JRC Scientific and Technical Reports

Workshop on Emerging Surveillance Capabilities & Requirements

JRC Ispra, Italy, 5 – 6 July 2011

M. Gemo, F. Andritsos

EUR 24958 EN - 2011

JRC
EUROPEAN COMMISSION

ipsc
Institute for the Protection and Security of the Citizen

The mission of the JRC-IPSC is to provide research results and to support EU policy-makers in their effort towards global security and towards protection of European citizens from accidents, deliberate attacks, fraud and illegal actions against EU policies.

European Commission
Joint Research Centre
Institute for the Protection and Security of the Citizen

Contact information
Address: JRC - TP 361 - Via E. Fermi, 2749 - 21027 Ispra (VA), Italy
E-mail: monica.gemo@jrc.ec.europa.eu
Tel.: +39 0332 783081
Fax: +39 0332 785145

http://ipsc.jrc.ec.europa.eu/
http://www.jrc.ec.europa.eu/

JRC 66757

EUR 24958 EN
ISBN 978-92-79-21467-7
ISSN 1831-9424 (online)
ISSN 1018-5593 (print)
doi:10.2788/80181

Luxembourg: Publications Office of the European Union

Printed in Italy

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

We would like to thank all the participants that definitively contributed to what, we believe, has been a fruitful workshop and comprehensive state-of-the art, successfully meeting its objectives of outlining capabilities, emerging trends, needs and of sharing best practices, methods and tools gathered in a network of prominent European research entities, leading system developers and operators / users in Intelligent Surveillance.

EXECUTIVE SUMMARY

On 5-6 July 2011, the Joint Research Center (JRC) of the European Commission organized a workshop on “Emerging Surveillance Capabilities and Requirements”. Around 40 R&D managers, researchers and practitioners from key European RTD institutes or academia, operators and leading system / equipment providers attended the workshop. The workshop was hosted by the Institute for the Protection and Security of the Citizen (IPSC) at JRC (http://ipsc.jrc.ec.europa.eu/), in Ispra, Italy.

The purpose of the workshop was to provide a forum where key scientists and practitioners could meet to address the following issues:

(a) Review the technology state of the art and the operational requirements;
(b) Anticipate technology trends and future needs, including testing and standards;
(c) Consider legal, regulatory and ethical aspects.

Some key-elements which arose during these sessions are worth being highlighted here:

The overview of current European projects and national initiatives showed some common concerns in terms of issues being addressed and including the following main topics standardization, testing and performance assessment under increasingly complex scenarios (365/24/7 video analytics service level, multiple image/video sources and sensors), impact of societal requirements/issues, such as privacy and security, in the planning, design and implementation phase of surveillance systems.

European networking and multi-disciplinary cooperation were often mentioned as relevant means to improve surveillance capabilities as well as to significantly enhance awareness of the societal values of concern. More precisely, the following points were cited:

- Surveillance capabilities need to be federated and coordinated at the European level.
- A mutual interest for cooperation for surveillance has been identified with the main aims of sharing best practices and common standards; the exchange of scientific staff as well as the use of national capabilities by other countries are some of the potential means to achieve it. The organization of workshops on the regular yearly basis was also suggested.
- Trend to pervasive observation / monitoring rendering data protection and privacy even more important issues which it is suggested to address in a future workshop.

Some new challenges for surveillance to be addressed in a very short-term future were introduced by several participants. A European certification framework for smart surveillance, the development of common privacy and performance testing methodologies, need for reference datasets, are some of these challenges.

This report summarizes the workshop’s contents and the main findings agreed during the closing session. It also contains all the PowerPoint format documents presented except the ones for which a confidentiality clause was required.

WORKSHOP OUTLINE

The ever increasing intensity and complexity of human activities require drastically new approaches on the information management, in particular regarding the public safety and security. This is also true for the information acquired through surveillance / monitoring systems, the great majority of which are currently based on closed circuit TV cameras (CCTV). There is a growing demand for novel intelligent, efficient and secure surveillance systems in both public and private spaces that should increase the safety and security of EU citizens without compromising their fundamental rights for privacy.

Aiming to review and anticipate the technology developments and trends, operational, regulatory, legal requirements, the Institute for the Protection and Security of the Citizen (IPSC) of the Joint Research Centre (JRC), European Commission, hosted a workshop on 5-6 July 2011, on "Emerging Surveillance Capabilities and Requirements" to promote and develop further exchange of technical and scientific good practices for Intelligent Surveillance.

The objective of this workshop was to bring together selected scientists and practitioners for the first time to share their recent advancements and findings concerning the current topic. Assessing and consolidating the state-of-the-art, making new issues and challenges rise, and drawing the list of recommendations to address them within a collaborative framework, were the main aims to be fulfilled.

Around 40 experts, researchers and practitioners European RTD institutes or academia, operators and leading system / equipment providers, met and shared their experience during this 2 day meeting (cfr. list of participants, p.38). Following the workshop introduction dedicated to the presentation of current IPSC programs and activities related to Surveillance and the Citizen, four sessions were run to cover the following topics:

- Session 1: Capabilities
- Session 2: Capabilities
- Session 3: Privacy
- Session 4: Requirements & Standards

The closing session was dedicated to presenting the key elements from each session, the underlining of the main workshop findings and the recommendations for future research and collaborations.

SESSION REPORTS

This section contains the following parts:

- Workshop Introduction: Overview of the current IPSC programs and activities in surveillance.
- Sessions 1-4: Summary of the state-of-the-art and emerging trends in Intelligent Surveillance Systems.
- Closing Session: Contains the recommendations emerged from the working sessions.

Workshop Introduction

OVERVIEW OF THE CURRENT IPSC PROGRAMS AND ACTIVITIES IN SURVEILLANCE

The overview of the current programs and projects was addressed during the workshop introduction. J. P. Nordvik, acting Head of Digital Citizen's Security Unit welcomed the starting of the meeting and F. Andritsos introduced the scope and aim of the meeting organized by newly created Surveillance and the Citizen (SURCIT) action.

The overview covered a summary of JRC/IPSC/SURCIT activities including the action research objectives, candidate research areas to explore for mutual collaborations and expertise from past/ongoing projects. The focus of action is on a citizen centred approach to Surveillance and framework for conditional autonomous surveillance respectful of citizens' needs/rights, as it is proposed in the SECURED, ASPIS and LOCCATEC projects.

FIVOS ANDRITSOS, EUROPEAN COMMISSION – JRC, "OVERVIEW OF THE CURRENT IPSC PROGRAMS AND ACTIVITIES IN SURVEILLANCE"

Dr. Fivos Andritsos obtained his degree in Mechanical Engineering from the Engineering School, University of Patras, GR on June 1977. On March 1982 he obtained his Doctoral degree (Ph.D.), from the same university. He is, since June 1986, a Scientific/Technical Officer of the European Commission, Joint Research Centre (JRC), Institute for the Protection and Security of the Citizen. He has worked on many projects, mainly related to Environmental Impact, Safety & Security, Remote Handling & Intervention, Emergency Management, Pollution Prevention & Containment and Systems Engineering in the Maritime, Energy and Nuclear application fields.
Prior to his JRC employment he has been Research Assistant, Research Associate and Lecturer at the Mechanical Engineering dept., Engineering School, University of Patras, GR. He has also been Guest Research Associate at the Mechanical Engineering dept., University of Newcastle upon Tyne, England and Associate Professor at the Technological Education Institute Patras, GR.
His Industrial experience includes work at the design dept., 301 Base Military Industry of the Greek Army, the Mixed Quality Control Group by the Hellenic Arms Industry, Greek Defence Ministry, Military Industry dept., Aeghion, GR and the Technical Services of PIRELLI (Tire Industry), Patras, GR.
He is the author or co-author of more than 110 scientific publications and is the inventor in 2 patents. He has set-up several successful cooperative projects, like ROTIS I & II, LOCCATEC, DIFIS and ASPIS.
He speaks and writes fluently in Greek, English, French and Italian.
Dr. Andritsos is of Greek nationality, was born in Athens on May 1954 and currently resides at Gavirate (VA), Italy.

Contact details:
Fivos.andritsos@jrc.ec.europa.eu
Tel. +39 0332 789599
Cel. +39 348 1411406

Session 1: Capabilities

This session was dedicated to the presentation of visual analytics and tracking capabilities in complex, cluttered settings. Queen Mary University of London gave an overview of their research in video analysis for human behavior understanding, NICE illustrated solutions for comprehensive security application areas and settings and Home Office CAST presented UK government capabilities for certification and performance evaluation of surveillance scenarios under real conditions. F. Andritsos, JRC IPSC chaired the session.

SHAOGANG GONG, QMUL, "SMART CCTV: MORE IS NOT"

Whether installed in private and public spaces, automatic visual analysis of behaviour in video data captured from closed-circuit television (CCTV) systems is one of the most compelling and significant developments in computer vision over the last 20 years. In his talk S. Gong presented application drivers, technology barriers, gaps and research challenges. Many of the issues raised are relevant to dynamic scene understanding in general, analysis of behavior in complex and uncertain visual environments, ranging from well-controlled private spaces to highly crowded public scenes. A key concern is the design of automatic visual learning systems and devices capable of extracting and mining salient information from vast quantity of data with minimum human intervention. Gong gave an overview of research for extracting relevant and meaningful semantic descriptions of salient objects and their behaviours for aiding decision-making and situation assessment.

Shaogang Gong is Professor of Visual Computation and head of the Computer Vision Group at Queen Mary College, University of London; elected a Fellow of the Institution of Electrical Engineers, a Fellow of the British Computer Society, and a member of the UK Computing Research Committee. His research investigates modelling visual behaviour patterns of action and activity based on object motion trajectories using visually augmented hidden Markov models and Bayesian belief networks. Since 1993 he have been working on modelling human faces, body dynamics, gestures and behaviour for human recognition, visually mediated interaction, communication and surveillance. Prof. Gong has published numerous papers in computer vision and machine learning, and two monographs: Visual Analysis of Behaviour: From Pixels to Semantics with Tao Xiang and Dynamic Vision: From Images to Face Recognition with Stephen McKenna and Alexandra Psarrou. He founded Queen Mary Vision Laboratory in 1993 and enjoyed immensely working with research students and postdoctoral researchers. he helped setting up and worked closely with Safehouse Technology (Clarity Visual Intelligence, now Lighthaus Logic) in 1998-2004 for developing commercial computer vision systems.

GUY LORMAN, NICE SYSTEMS, "VIDEO ANALYTICS THE NICE WAY"

G. Lorman presented NICE capabilities and product performance requirements enabling organizations to anticipate, manage and mitigate security, safety and operational risks. By capturing relevant and meaningful information from a multitude of sources, and then analyzing and correlating between siloed inputs for valuable insight, organizations are armed with a complete picture and gain situational awareness. Comprehensive in nature, NICE solutions enable organizations to effectively and consistently implement their response plans, become more proactive and share information efficiently for a collaborative response. By capturing relevant evidence and auditing response, organizations achieve an in-depth understanding of situations and events and the way they are handled.

Guy Lorman – Product Manager – NICE Security Group

In the last 3 years Guy was leading the Video Analytics products offering of NICE Systems, prior to that he have managed the system engineering team for video surveillance products at NICE Systems, and overall he has more than 10 years of experience in the Video Surveillance domain with strong technical and market understanding. Guy holds a B.Sc in Electrical and Computers Engineering from the Ben Gurion University in Israel.

With solutions tailored to meet their specific needs, many of the world's most security-conscience organizations—airports, public transportation, seaports, first responders, critical facilities, utilities, banks and homeland security— rely on **NICE Security** Solutions to enhance their security and safety operations. More than 5,000 enterprise class customers around the world, including 9 out of the top 10 U.S. cities, NYPD, New Jersey Transit, FAA (Federal Aviation Administration), Eiffel Tower, Beijing Metro, Dallas Fort Worth Airport and many more in the government, public safety, transportation, critical infrastructure and enterprise campus sectors, entrust their security and safety needs to NICE.

STUART RANKIN, KINGSLEY SAGE, UK HOME OFFICE CAST, UK, "CURRENT INITIATIVES TO DRIVE PERFORMANCE AND INNOVATION IN VIDEO DETECTION SYSTEMS"

S. Rankin presented UK CAST initiatives, developed in partnership with CPNI promoting performance evaluation of Visual Analytics systems to help in policing and counter terrorism operations. In particular, he illustrated the i-LIDS library of CCTV video footage datasets based around six 'scenarios' central to government requirements. The footage accurately represents real operating conditions and potential threats. Latest developments include multiple-camera tracking and new imaging technologies datasets, as well as operator performance benchmarking.

Dr Kingsley Sage is a senior scientist working in the Vision Based Security Systems team based at CAST Langhurst near Horsham, West Sussex in the UK. Kingsley has a Bachelor's degree in Electronic Engineering and Masters and Doctorate degrees in Computer Science and Artificial Intelligence specialising in machine learning and computer vision. Kingsley was a former research fellow in the cognitive computer vision team at the University of Sussex, and also worked as a research officer on the FP5 cognitive computer vision project ActIPret with partners FORTH (GR), Czech Technical University (CZ), ACIN at the University of Vienna (AT) and Profactor (AT/DE). Kingsley has over 20 years experience of the development and evaluation of vision systems for security and surveillance applications.

Contact details
Dr Kingsley Sage
Kingsley.sage2@homeoffice.gsi.gov.uk
Tel: +44 (0)1403 213811

Stuart Rankin is a Scientific Officer working in the Vision Based Security System team based at CAST Langhurst near Horsham, West Sussex in the UK. Stuart has an engineering degree in Electronics and Broadcasting, and a background in broadcast system engineering and electronics systems. Stuart has worked for CAST for a number of years focusing on the evaluation of video analytics systems for security purposes under the i-LIDS program including the development of i-LIDS scenario datasets. He is also involved in projects evaluating human performance in detection tasks and other video security work.

Contact details
Stuart Rankin
stuart.rankin@homeoffice.gsi.gov.uk
Tel: +44 (0)1403 213836

CAST provides advice and operational support for the UK Home Office and its partners on any issue relating to science and technology, creating new solutions where none exist. We help the Home Office meet its strategic objectives in policing, crime reduction, counter terrorism, border security and identity management.

CAST works in partnership with the Police Service, UK Border Agency and other key stakeholders. CAST's work helps the Home Office achieve its key objectives to:

- help people feel secure in their homes and communities
- cut crime, especially violent, drug and alcohol related crime
- lead visible, responsive and accountable policing
- protect the public from terrorism
- secure our borders and control migration for the benefit of our country
- safeguard people's identity and the privileges of citizenship
- support the efficient and effective delivery of justice

CAST is based at two UK sites, Sandridge near St Albans and Langhurst House in West Sussex.

Session 2: Capabilities (cont'd)

This session continued the review of surveillance capabilities and focused issues of multi-camera tracking/re-identification methods and next generation communications thanks to four presentations from the Italian Institute of Technology (IIT-UNIVR), the Queen Mary University of London (QMUL), the Italian Universita di Modena e Reggio Emilia (IMAGELAB/UNIMORE) and the Turkish KOÇ University (KOÇ). F. Andritsos, JRC IPSC chaired the session.

VITTORIO MURINO IIT – UNIVR, "FROM DETECTION & TRACKING TO THE ANALYSIS OF SOCIAL BEHAVIOUR"

V. Murino from the Istituto Italiano di Tecnologia, PLUS Lab, talked about extending detection and tracking methods to recognise social cues to be used to design robust and effective an automatic system for human behavior analysis. So far, video surveillance and monitoring were mainly focused on low-level information extraction for scene understanding, in which the main video processing methods aimed at modeling the background information, detecting and tracking objects and persons, or analyse object/scene motion in general.

Recently, the work moved on to analyze and understand the real behavior of people in unconstrained settings, and the necessity to go beyond the above paradigm has been realized, trying to integrate social/psychological findings in the computational algorithms. Actually, the next generation of video surveillance systems must take into account studies in social sciences to model and understand human behavior in several scenarios.

Vittorio Murino is the Senior Scientist heading Computer Imaging and Pattern analysis, Learning, and image Understanding Systems laboratory (PLUS) laboratory focusing on activities related to the analysis and understanding of images and patterns in general, thus representing a reference for other IIT Departments and labs which have to deal with such kind of data.

One of the primary goals is to design and develop innovative video surveillance systems, characterized by the use of highly-functional smart sensors and advanced video analytics features. To this end, PLUS performs cutting edge research in computer vision and pattern recognition, but also in biometrics, multimodal data and sensor fusion, sensors networks, and embedded computer vision. Further, another target of the lab is to explore novel strategies in biomedical image analysis and bioinformatics, due to the versatility of the techniques it can manage.

ANDREA CAVALLARO, QMUL, "OBSERVING PEOPLE AND THEIR BEHAVIOURS"

Event recognition and behaviour analysis methods on standard datasets were demonstrated by A. Cavallaro of the QMUL Electronic Engineering and Computer Science department. Key open issues related to scalability and performance evaluation were underlined.
Recognising behaviours and their variations is a fundamental capability for the surveillance of large areas. The presentation covers data and context driven algorithms for the observation of people using multiple sensors in order not only to help cataloguing and mining large volumes of videos, but also to alert operators by selecting the most appropriate sensor and focusing more effectively on portions of a monitored scenes where sensors are observing activities of interest.

Dr. Andrea Cavallaro is Professor of Multimedia Signal Processing at Queen Mary University of London. He received the Ph.D. in Electrical Engineering from the Swiss Federal Institute of Technology (EPFL), Lausanne, Switzerland and the Laurea (Summa cum Laude) in Electrical

His research includes multimedia signal processing, perceptual semantics and interactive media computing. In particular, he is interested in audiovisual content analysis and performance evaluation with application in advanced surveillance, semantic coding and multi-sensor networks.

RITA CUCCHIARA, IMAGELAB/UNIMORE, "INTEGRATION OF MULTIPLE SENSOR MODALITIES FOR DETECTING INTRUDERS IN WIDE OPEN AREAS"

Innovative intruder detection approaches are needed to ensure safety and security in wide open areas. R. Cucchiara from UNIMORE presented recent research activity on complementary use of multiple sensing modalities. Considering wide areas with no obliged entrances, standard techniques (such as badges, or fingerprint authentication, face recognition or standard keys) are not adequate to the task. The identification of intruders in groups of people represents a challenging scenario where coordination between cameras can be certainly used but this solution is not enough. Imagelab researches to go beyond pure vision-based approaches by integrating the use of distributed cameras with the RFID technology. The new approach proposed a system that "maps" RFID tags to people detected by cameras by using sophisticated techniques to filter the singular modalities and an evidential fusion architecture, based on Transferable Belief Model, to combine the two sources of information and manage conflict between them.

Imagelab@Softech is a research lab mainly devoted to research on computer vision, multimedia and pattern recognition. Imagelab has been created in 1999 by **Prof. Rita Cucchiara** and is located in the Department of Information Engineering of the University of Modena and Reggio Emilia in Modena, Italy. Softech is a recently created center for innovation which has the main vision to transfer knowledge in the field of computer science from the research centers to innovative companies in the Emilia-Romagna region and not. Imagelab@Softech is currently composed of 5 staff members, 5 Phd students, 2 post-docs and an honorary affiliate (Massimo Piccardi, University of Technology at Sidney). The main research activities of Imagelab@Softech are related to video surveillance and video analytics, multi-sensor processing for security applications, multimedia processing, ICT for cultural heritage, machine vision systems for industrial applications, medical imaging and management of visual digital libraries (more information at http://imagelab.ing.unimore.it).

OZGUR BARIS AKAN, KOÇ, "NEXT-GENERATION COMMUNICATIONS FOR PERVASIVE SURVEILLANCE"

In this talk, O. B. Akan introduced some of the next-generation communication technologies that could be used towards the realization of emerging pervasive surveillance systems. More specifically, cognitive radio sensor networks, nanoscale communications and wireless nanosensor networks, radar sensor networks with ultra-wideband (UWB) will be explored for the development of pervasive surveillance techniques along with challenges and open research issues.

Ozgur Baris AKAN is currently Associate Professor with the Department of Electrical and Electronics Engineering, Koc University and the Director of Next-generation Wireless Communications Laboratory (NWCL). His current research interests are in next-generation wireless communications, cognitive radio networks, wireless sensor networks, satellite and space communications, underwater acoustic communications, signal processing for wireless communications, wireless multimedia communications, information theory, nanoscale, molecular and quantum communications.

Session 3: Privacy

This session was dedicated to the legal, regulatory and ethical aspects related to Intelligent Surveillance systems. Four presentations were given by the Fraunhofer Institute of Optronics, System Technologies and Image Exploitation (IOSB/ASM) addressing both technical and privacy issues in tracking and re-identification analitics, the European Data Protection Supervisor (EDPS), the Interdisciplinary Centre for Law & ICT (ICRI) and the Fraunhofer Institute of Optronics, System Technologies and Image Exploitation (IOSB/SKA). F. Andritsos, JRC IPSC chaired the session.

EDUARDO MONARI, FRAUNHOFER IOSB, "TOWARDS PRIVACY-ENABLED TRACKING AND PEOPLE RE-IDENTIFICATION IN MULTI-CAMERA SYSTEMS"

In the last decades video analytics develops towards more and more powerful multi-camera surveillance systems. In his talk, E. Monari gave an overview about current research activities on multi-camera person tracking and person re-identification, highlighting issues and capability gaps regarding one of the most challenging surveillance tasks in camera networks.
Hereby the features extracted by video analytics for automated person re-identification and tracking over several cameras changed significantly from non (or less) person-related features like position, color, texture, etc., to soft-biometric and biometric features. Only using this individual-related features a robust re-identification of persons in large camera system with non-overlapping field of views is possible. Subsequently, in context of multi-camera systems, the privacy issue becomes more and more important.
. In particular the privacy aspects of extraction of soft-biometrics and biometric features for the purpose of automated person recognition will be discussed. Finally, some ideas and future work on methods for setup a "privacy enabled multi-camera system" are presented.

Mr. Eduardo Monari holds a diploma and a master degree in Electrical Engineering and Communication Technology, both from the University of Applied Sciences of Karlsruhe. Since 2011 he holds a PhD degree in Electrical Engineering from the Karlsruhe Institute of Technology. Since 2005 he works as research employee at the IOSB with the dept. for Autonomous Systems and Machine Vision. He is currently head of the research group "Image-based Real-time Systems".

The **Fraunhofer-Gesellschaft** undertakes applied research of direct utility to private and public enterprise and of wide benefit to society. The Fraunhofer-Gesellschaft is the largest organization for applied research in Europe with more than 80 research units, including 60 Fraunhofer Institutes, at different locations in Germany, 18.000 employees and an annual research budget of € 1.7 billion.

The core competences of the **Fraunhofer Institute of Optronics, System Technologies and Image Exploitation (IOSB)** in Karlsruhe, founded in 1956, are in the three domains of image interpretation, control systems, and information and communication management. In the area of image processing and analysis, IOSB is the focal research institute of the Fraunhofer Gesellschaft. The Fraunhofer-Institute on Optronics, System Technology and Image Exploitation with almost 300 researchers on the field of image exploitation represents Europe's largest research institute for image and video processing, pattern recognition, image analysis for reconnaissance, surveillance and situation awareness.

The department ASM – Autonomous Systems and Machine Vision is one of the capital departments on video analytics. ASM develops video processing algorithms and (sub)systems for object detection, localization, classification and recognition. Typical applications in this fields are automatic processing of airborne images, intelligent video-based surveillance.

LAURENT BESLAY, EDPS, "PRIVACY-BY-DESIGN AND SURVEILLANCE TECHNOLOGIES: CHALLENGES AND OPPORTUNITIES"

After a brief introduction regarding the mission of the EDPS and its interactions with EU research projects, L. Beslay illustrated his intervention with two examples: body scanner and how it was tackled by EU institutions and a more prospective one related to a crime scene in an Internet of Things environment. These two examples offered the opportunity to highlight privacy and data protection issues and to suggest tools in order to address appropriately those issues.

Laurent BESLAY works as a scientific project manager for the Joint Research Centre of the European Commission the IPSC (Institute for the Protection and Security of the Citizen) in the Digital Citizen Security Unit since September 2011. From 2004 until September 2011, he worked as Coordinator on Security and Technology for the European Data Protection Supervisor based in Brussels, where his responsibilities included Security and technology coordination of prior-checks opinions, policy opinions, complains, security inspections and audits of EU large scale IT systems. He previously worked, for six years, for the Joint Research Centre of the European Commission, the IPTS (Institute for Prospective Technological Studies) as a project officer in the field of cyber-security. He holds a Post-master's degree in Global Management of Technological Risks and Crisis (University of Paris, la Sorbonne) and a Master's degree in International Relations.

The **EDPS**' general objective is to ensure that the European institutions and bodies respect the right to privacy when they process personal data and develop new policies. A number of specific duties of the EDPS are laid down in Regulation (EC) No 45/2001. The three main fields of work are:

- *Supervision*: the EDPS monitors the processing of personal data in the EU administration and ensures compliance with the data protection rules. The supervisory tasks range from prior checking processing operations likely to present specific risks, to handling complaints and conducting enquiries.
- *Consultation*: the EDPS advises the European Commission, the European Parliament and the Council on proposals for new legislation and a wide range of other issues having an impact on data protection.
- *Cooperation*: the EDPS cooperates with other data protection authorities in order to promote consistent data protection throughout Europe. The central platform for cooperation with national data protection authorities is the Article 29 Working Party.

FANNY COUDERT, ICRI-KUL, "MANAGING PRIVACY IN EMERGING VIDEO SURVEILLANCE SYSTEMS"

Data protection laws impose a series of constraints on the implementation of video surveillance networks. These requirements are however often neglected during the design of the systems and only handled at the very end of the implementation phase. What are these constraints? How could they be dealt with? This presentation gives an overview of the rationale of data protection requirements and focuses on the main problems that arise in the context of emerging video surveillance technologies.

Fanny COUDERT obtained her law degree in French law from the University Panthéon-Sorbonne and in Spanish law from the University Complutense of Madrid (2000). In 2001, she obtained a Master degree in ICT Law (special award for dissertation) at the Universidad Complutense de Madrid, and in 2004, she obtained a pre-doctorate degree (D.E.A) at the same

University (Magna Cum Laude). During her doctorate training studies, she worked as a data protection auditor, and as an in-house lawyer in a consumer organization. She is a member of the Madrid (2001) Bar Association.
Fanny joined ICRI in July, 2006 where she conducts research in the field of privacy. She is currently working on the project "Tackling cybercrime: digital forensics for embedded computer systems and social computing applications", funded by K.U.Leuven. She has previously been working on several European projects: the FP7 EU project +Spaces (Policy Simulation in Virtual Worlds) where she focuses on privacy in virtual worlds, the FP7 EU project SCOVIS (Self-Configurable Cognitive Video Supervision) and the EU FP6 projects DYVINE (Dynamic visual networks) where she focused on privacy and video surveillance, and the FP7 project TURBINE (Trusted Revocable Biometrics Identities) where she focused on privacy and biometrics. She has also been actively involved in the Network of Excellence FIDIS (Future of Identity in the Information Society, www.fidis.net) where she has contributed to deliverables on the processing of location data, mobile marketing, biometrics, ID Theft and forensic/risk profiling. She has also worked on e-voting for the Belgian project BEVOTING.
In March 2009, she became an associate researcher of the Institute of Criminal Law of the K.U.Leuven.
She started in 2010 a PhD on the topic of "The purpose specification principle in the Area of Freedom, Security and Justice: towards renewed data protection principles for information-based practices in the field of Security" under the supervision of Prof. Dr. J. Dumortier and Prof. Dr. F. Verbruggen.

K.U.Leuven is the largest Belgian academic institution and one of the oldest European universities. In 2008, the research expenditure of the University reached the level of 330 million euro and K.U.Leuven researchers published 4.047 publications in international peer-reviewed academic and scientific journals. K.U.Leuven is also a member of the League of European Research Universities (LERU), a group of twenty European research-intensive universities committed to the values of high-quality education in an internationally competitive research environment. More than 200 K.U.Leuven researchers are permanently working on information and communications technology related issues. They belong to different university departments with a strong tradition in multidisciplinary research on information and communications technology issues.

The Interdisciplinary Centre for Law & ICT (www.icri.be) is a research centre at the Faculty of Law of K.U.Leuven dedicated to advance and promote legal knowledge about the information society through research and teaching of the highest quality. ICRI is also among the founding members of The LEUVEN Center on Information and Communication Technology (LICT) and IBBT. ICRI's current staff counts 2 full time professors, 3 full time postdoctoral researchers, 15 fulltime doctoral and legal researchers, 2 full time administrative assistants and 7 affiliated researchers.
ICRI is committed to contribute to a better and more efficient regulatory and policy framework for information & communication technologies (ICTs). Its research is focused on the design of innovative legal engineering techniques and is characterised by its intra- and interdisciplinary approach, constantly aspiring cross-fertilisation between legal, technical, economic and socio-cultural perspectives. By conducting groundbreaking legal research in a spirit of academic freedom and freedom of inquiry, ICRI aspires to a place among the centres of excellence in the area of law & ICT in Europe and beyond. ICRI has carried out several studies and consultancy assignments with a strong tradition in multidisciplinary research on information and communications technology issues.

HAUKE VAGTS, FRAUNHOFER IOSB, "**PRIVACY ENFORCEMENT FOR SURVEILLANCE SYSTEMS**"

In the second talk from Fraunhofer IOSB, H. Vagts proposed a privacy aware data-centric framework for smart surveillance systems. Especially, when surveillance deployments are

enhanced with other sensor, e.g., RFID or acoustic sensors, smart video surveillance systems put privacy at risk and people are concerned about it. Hence, new approaches for privacy enforcement are required that fulfill legal requirements and achieve acceptance of operators and observed people. New solutions are proposed to create privacy enabled multi-camera systems that follow the “privacy by design” principle.

Mr. Hauke Vagts received his diploma degree in Computer Science from the University of Technology Darmstadt in 2007 and is currently working towards his PhD at the Karlsruhe Institute of Technology. Mr. Vagts deals with data protection and IT security in intelligent monitoring systems. His special interest is the interdisciplinary research on issues of user acceptance and validity can be answered holistically. His work takes place in close cooperation with the Department of secure communication architectures (SKA), the Fraunhofer IOSB. He heads the research group identity protection and management.

The department SKA at Fraunhofer Institute of Optronics, System Technologies and Image Exploitation (IOSB) – The apartment SKA develops secure IT architectures for business environments. This includes, e.g., VPN structures, intrusion detection, firewalling and content security. SKA is especially working on interdisciplinary solutions for privacy enforcement that consider ethical and legal aspects as well as state-of-the-art technology and end user requirements.

Session 4: Requirements and Standards

The theme of “requirements and standards for operational surveillance systems ” was addressed thanks to four presentations by Thales Communications and Security (THALES), the Netherlands Organization for Applied Scientific Research (TNO), the “Régie Autonome des Transports Parisiens” (RATP) and the Multitel Research Centre. The session was chaired by F. Andritsos, JRC IPSC.

JEAN FRANCOIS SULZER, THALES, “VIDEO-SURVEILLANCE STANDARDIZATION AND EXPECTED OPERATIONAL BENEFITS”

With generalization of video on IP, CCTV systems have become IT oriented, generating obvious needs for interoperability. The requirements are both real-time to fuse information from different owners and post-event for forensics investigations. J.F. Sulzer illustrated the several standardization initiatives under way and he explained how they proceed in a coordinated manner. The talk highlighted ISO/TC223/WG5 activities that concentrate on the needs of societal security. The corresponding minimum mandated interoperability criteria were discussed and the benefits for the developers of "smart video" algorithms explained.

Jean-François SULZER is Responsible of the Advanced Projects at Thales Communications & Security (France) and is currently convenor of both the AFNOR and the ISO working groups of ISO/TC 223 on Societal Security.

THALES is an international electronics and systems group serving defense, aerospace, security and services markets.
THALES Security Systems activities encompass the design, delivery and integration of high-technology systems to protect critical infrastructures for business corporations, local authorities and government agencies worldwide. These systems cover all aspects of overall security: site and public event security, safety and security operational and crisis management centres, homeland security solutions, identification systems, IT security, environmental security.
These security solutions are a key component of the Security solutions and services Division (D3S), which with 25% of its revenues, represents now the civilian pillar of Thales, dedicated to mission critical information systems.
Thales Security Systems is based in Velizy, near Paris, and has operations all over Europe, in the Middle East, China Australia, South-america.
Thales is a leading European player in key segments of the security market: integrated security systems (access control, video surveillance, intrusion detection, perimeter protection, supervision), transportation, secure identification solutions, CBRN detection systems, secure information systems.

JEROEN VAN REST, TNO, ‘‘A MATURING INDUSTRY DEPENDS ON STANDARDS IN ENGINEERING SURVEILLANCE SYSTEMS’’

High quality systems engineering is critical in a maturing surveillance industry. In his talk reporting the RTO perspective, J. Van Rest outlined -among other needs- three particular issues:
- Interoperability: we need data standards that describe human behavior. It is currently possible to describe tracks and faces, but intent, stress level and many other (physiological) parameters are missing.
- Transparency in performance: surveillance systems need to be custom tailored. This should not prevent comparing their performance on a level playing field. If a certificate states: "fit for virtual fencing" on a product, how much room for errors has the installer left?

- Legal and ethical transparency: privacy-by-design should facilitate cross country acceptance of surveillance products and systems. But how?

Jeroen VAN REST MSc. based at TNO The Hague, The Netherlands has a background in Computer Science and presently holds a position as scientist and consultant in the field of intelligent sensors. His specific expertise is in the area's of surveillance camera's, privacy and designing artificial intelligence systems.

Security has shifted from a collection of ad hoc reactions to incidents to a cohesive set of measures and effects. The potential impact and the cascading effects of incidents as well as the social cost-benefits profile of security measures requires a comprehensive approach and orchestration based on risk and effect. Perception and acceptance are key to chosen solutions and much has to be seen in the international context.

TNO's aim is to develop innovative concepts for surveillance, enforcement and detection, whereby maximum cost-effective results in surveillance and detection can be achieved by delineating environment, time and resources. TNO wants to implement this together with partners. To this end TNO is looking for faster, more specific actions for enforcement, detection and assistance, better prevention of incidents by building up an information position, lower deployment of professionals through citizen participation and supporting technology, and acceleration of the development cycle for surveillance systems.
It's the intention of TNO to improve equipment and the competencies of personnel and restructure implementation capacity in a revolutionary way, with the goal of more effective, efficient and safe action by the operational security services in the event of incidents, disasters and large-scale crises. This includes costeffective, multidisciplinary action using optimal means of protection and adequate information management. This should produce better, coordinated decision-making at all levels, greater self-sufficiency among citizens following incidents or disasters, and improved information and availability of knowledge to mobilise government, companies and citizens.
Structure societal infrastructures (like neighbourhoods, public transport, vital infrastructure, polders, transport chains, logistics and industrial systems) such that security and safety problems can be prevented, contained or solved in a balanced way, and (security) organisations are able to learn and thus adapt to societal and market dynamics. Electricity, water and transport are priorities. This requires the reconsideration of efficient economic structure and the effective resilience of societal systems, plus restructuring on the basis of properties like resilience, sustainability and graceful degradation.

FABRICE SABOURIN, RATP, "RATP CONNECTING PASSENGERS: DEPLOYING OPERATIONAL VIDEO ANALYSIS IN PARIS METRO SYSTEM"

F. Sabourin presented RATP CCTV systems in its public and private spaces. Public spaces CCTV is used 'live' for security and traffic regulation; recorded images are mostly used by Police for crime investigation. Video analysis is being progressively used in train stabling zones; it helps in preventing intrusion and graffiti. Plans for the development of video analysis throughout the system aim to generate alarms on 'abnormal' situations, to prevent proactively a wide variety of crimes.
None of these systems are totally and perfectly operational, due to the extremely intense passenger traffic, and for technical reasons (including the quality of images). To go towards a fully operational system, RATP will start experimenting a video analysis operational system, dedicated to the large Châtelet - les Halles Metro and RER hub.

CYRIL CARINCOTTE, MULTITEL, "INTEGRATING INNOVATIVE AUDIO/VIDEO ANALYSIS TOOLS IN CCTV PLATFORM FOR URBAN TRANSPORT: TURIN AND PARIS USE-CASES"

C. Carincotte ended the session presenting innovative audio/video surveillance components for underground station in VANAHEIM (www.vanaheim-project.eu). The project trial sites are Gruppo Torinese Trasporti (Turin metro) and Régie Autonome des Transports Parisiens (Paris metro), in which the project partners will integrate these innovative audio/video surveillance components, within a market-based cctv supervision system. The talk gave an overview on the topics covered by the partners during the project first year; audio/video scenarios of interest definition, audio/video dataset acquisition, preliminary integration and main audio/video research studies (activity recognition and anomaly detection, and human action recognition such as head localization and body orientation, group detection or people flow monitoring).

Dr Cyril CARINCOTTE received the electronics and informatics engineering degree from the Institut Supérieur d"Electronique et du Numérique (ISEN), Lille, France in 2002. He received his M.Sc. and Ph.D. degrees from Paul Cezanne University, Marseille, France, in Signal and Image processing respectively in 2002 and 2005. From Oct. 2005 to Feb. 2006, he worked with the Ecole Généraliste d'Ingénieurs de Marseille (EGIM) and GSM department of Fresnel Institute as Teaching and Research Assistant. Since March 2006, he joined the Image Department of Multitel, first as researcher in applied image and video processing, and since February 2010 as head of Image department. From March 2006 to September 2008, he was in charge of Multitel activities in the IST FP6-027231 CARETAKER project, in which he coordinated the event recognition work package and the related integration task. Since April 2008, he is managing Multitel activities in EDA HDR-HF project, in which he is in charge of the multimedia application subsystem. Since February 2010, he is coordinating the FP7-248907 VANAHEIM project, which aims at studying and integrating innovative audio/video analysis for urban transport (metro) CCTV surveillance platform. His research interests mainly focus on applied video content analytics and video surveillance, and their integration into innovative and real-scale prototypes/systems.

MULTITEL, non-profit organization created in 1999, is a Research Centre in scientific technology supported by a multidisciplinary team including engineers and technicians, as well as a sales structure. Its aim consists in developing and implementing innovative projects in collaboration with local and international companies. Multitel has developed its activities in 5 scientific fields, namely, Human-machine interfaces, Image processing, Applied photonics, Network Engineering, and ERTMS certification. Since its creation in 2001, Multitel Image department has been highly active in the image and video analysis research area, through numerous participations to national and European research projects as well as commercial prototypes building. As non-profit organization, and so as effectively capitalize on its innovations, Multitel creates new companies (spin-off) solely devoted to manufacturing and marketing its inventions. Since October 2003, the ACIC spin-off (www.acic-tech.be) is thus in charge of providing video analytics or video content analysis (VCA) solutions for a wide range of surveillance applications like perimeter protection, virtual line crossing, people counting, automatic incident detection and road data gathering, stopped car or abandoned objects.

Intervening Experts

Fredrik HERTZBERG, Engineering Manager Core Technologies – Analytics & Systems, Axis Communications
Ted HARTZELL, Lead Engineer Core Technologies – Systems, Axis Communications

AXIS is an IT company offering network video solutions for professional installations. The company is the global market leader in network video, driving the ongoing shift from analog to digital video surveillance. Axis' products and solutions focus on security surveillance and remote monitoring, and are based on innovative and open technology platforms
http://www.axis.com

AXIS Core Technologies – Analytics & Systems is responsible for the long term technology development of video analytics algorithms and intelligent systems functionality within Axis Communications.

Michael HÖYNCK holds a MSc degree in Electrical Engineering from Technical University Berlin and a doctoral degree in Communications Engineering with a focus on video content analytics from RWTH Aachen University, Germany.
In 2005, he started his career with Bosch at the Research and Technology Center North America in Pittsburgh (PA), where he held various positions ranging from Research Engineer to Program Manager, working on Signal Processing Technologies with applications in smart and responsive environments.
Since 2009, Dr. Höynck is a Senior Manager of Corporate Research of the Robert Bosch GmbH, working with his group on topics related to commercial application of image- and video processing. He has experience in intelligent computer vision systems for various markets and domains, focusing on innovative solutions for security systems and autonomous robotic systems.

The **BOSCH Group** is a leading global supplier of technology and services. In the areas of automotive and industrial technology, consumer goods, and building technology, some 275,000 associates generated sales of 38.2 billion € in fiscal 2009. The special ownership structure of Robert Bosch GmbH guarantees the entrepreneurial freedom of the Bosch Group, enabling the company to plan over the long term. Ninety-two percent of the share capital is held by Robert Bosch Stiftung GmbH, a charitable foundation. Bosch considers occupational training an integral part of its social responsibility. Worldwide more than 6,000 young people, of whom around 4,400 are in Germany, receive high-quality training of this kind. In the field of research and development with some 33,000 associates, Bosch's expenditure totals 3.6 billion € (9.4 % of sales). In 2009 we applied for 3870 patents for inventions worldwide. At Bosch, the way we do business is in tune with environmental protection. Already back in 1973, the Bosch Group specified protection of the environment as being one of its business objectives – it is therefore assigned the same high importance as the quality of Bosch products and the efficiency with which¬ the company does business. Bosch is determined to enhance the quality of life of people all around the world with solutions that are both innovative and beneficial. "Reliability, credibility and legality are the essential factors for the business success of the Bosch Group." (Hermann Scholl, Chairman of the Supervisory Board)
The Corporate Sector Research and Advanced Engineering (CR) is responsible for the development of new technologies and product innovation in areas such as automotive electronics, car multimedia, energy and body systems, safety and security systems, software engineering , digital signal processing algorithms, very large scale integration, and manufacturing techniques. We represent a Corporate Research working group of the Robert Bosch GmbH targeting advanced video surveillance systems that enhance the current product portfolio of smart

cameras of Bosch Security Systems GmbH. Our mission is research and advance development of system concepts and intelligent video analytics technology for a broad range of smart camera products of Bosch.

Mr. Bernhard STROBL (MSc) is Deputy Head of the Business Unit Video and Security Technology at AIT since 2006. He graduated in 1986 as MSc, in Informatics at the Technical University Vienna, Austria. He started to work as a Researcher at the AIT in 1987. In this time he was involved in specification, implementation and project management of several projects for building hardware and software for video encoding, decoding, transmission and storage. For AIT he developed a patent for a video encoding algorithm. He worked in several national and international projects. At the moment he is involved in two major activities: Management of an AIT intern project named Video Archive Search and as Co-ordinator of a national funded project of the KIRAS Programme of Austria named SECRET (Search of Critical Events in Videoarchives) (http://www.kiras.at/gefoerderte-projekte/programmlinie-2/secret/). In addition he is leading the AIT internal program all4surveillance http://www.ait.ac.at/research-services/research-services-safety-security/all4surveillance/?L=1

AIT Austrian Institute of Technology (AIT) will contribute to this project by the Safety and Security Department (http://www.ait.ac.at/departments/safety-security) with the Video- and Security Technology research group. The department has large experience with both EU projects (SENSE, ADOSE, DECOS, EPICS, SANY, ROBOTS@HOME and many more) as well as numerous nationally funded research projects. The AIT Austrian Institute of Technology is an Austrian research institute with a European format and focuses on the key infrastructure issues of the future. The AIT, which comprises five independent and performance-driven departments (Energy, Mobility, Health & Environment, Safety & Security and Foresight & Policy Development), works in close collaboration with industry and customers from public institutions, striving to increase their added value through innovation and new technologies. The AIT Austrian Institute of Technology is a highly-specialised Research & Development partner focusing on key infrastructure issues of the future. It is geared towards developing the methods and technologies of tomorrow for the innovations of the day after tomorrow. The Republic of Austria (through the Federal Ministry for Transport, Innovation and Technology) has a share of 50.46%, while the Federation of Austrian Industries owns 49.54% of the AIT Austrian Institute of Technology.

The mission of the Safety and Security Department is to make a significant contribution to ICT and to devote concerted efforts for guaranteeing operational efficiency and reliability of all critical infrastructures – both private and public – especially in times of potential ecological, economic and political crisis. Based on the evaluation, further development and provision of future-oriented technologies along with innovative procedures and sophisticated processes we are committed to fostering the roll-out of national infrastructures as well as the deployment of state-of-the-art technologies in the area of public administration (eGovernment, eEnvironment), energy, health care (eHealth), transportation, and telecommunications as well as the business and industrial sector with a view to positioning Austria at the forefront of the European ICT industry.

I

Closing Session

The closing session was dedicated to the two following points:

- Synthesis and agreement on main workshop findings,
- Recommendations for future research and collaboration.

SYNTHESIS AND AGREEMENT ON MAIN WORKSHOP FINDINGS

There is a list of crucial topics that are currently being studied by the Surveillance community:

- Need for improved federation/coordination of surveillance capabilities at European level
- Testing and performance assessment capabilities for situational awareness surveillance,
- Enhanced integration of societal concerns throughout all development stages
- Trend to pervasive observation / monitoring accruing societal concerns

Several research projects have been funded and are currently being developed promoted by European Security Research to sustain surveillance capabilities in these concerns. A European certification framework for smart surveillance and development of common privacy – performance testing methodologies was highlighted by TNO as a challenge to be addressed in the short-term.

The composite nature of the European Union including 27 different Member States, implies a very specific European context concerning Surveillance issues. European capacity in terms of M&S for Smart Surveillance is fragmented over different public, private and research bodies, often with the result of non-optimum exploitation of resources and work duplication. While there exists a limited number of initiatives to co-ordinate some national or sectoral M&S efforts, Europe lacks, amongst other things, a mechanism to federate existing M&S efforts, benchmark existing methods and tools, provide referenced datasets for validation purposes, foster collaboration and promote best practices. Therefore, some dedicated analyses are required to better understand the features and specificities of the European context.

Several scientific, regulatory and technical issues that currently need to be addressed by the Surveillance M&S community have been expressed during the workshop and can be listed as follows:

- Data issues: quality, availability, accessibility…
- Validation issues: past events databases to be built, experiences to be made use of…
- Standards & Interoperability for data and models

RECOMMENDATIONS FOR FUTURE RESEARCH AND COLLABORATION

- International cooperation & networking

All parties are encouraged to participate in the Commission call on security (closure Nov.11).

The exchange of scientific personnel was put forward as a possible means for joint cooperation between research technology organisations, academia and private operators / developers.

The series of workshops concerning intelligent Surveillance will be continued. It is suggested to organize them on a regular yearly basis.

Joint research projects should be promoted and built. One proposal was preliminarily expressed to examine how the privacy-by-design approaches could be incorporated in Surveillance.
I

APPENDIXES

Appendix 1: Workshop Invitation Letter

Workshop

Emerging Surveillance Capabilities & Requirements

JRC Ispra, July 5-6, 2011

The Joint Research Centre of the European Commission, in the context of its own research action *Surveillance Technologies and the Citizen* (SURCIT), is organizing a workshop on the *Emerging Surveillance Capabilities & Requirements*. The workshop aims to bring together prominent EU research entities, surveillance system developers and operators / users of surveillance systems in order to:

- Review the technology state of the art and the operational requirements,
- Anticipate technology trends and future needs, including testing and standards,
- Consider legal, regulatory and ethical aspects

Possible application areas include in particular:

- Tracking in complex, cluttered environment (automated calibration & colour constancy, tracking and re-identification of people etc.)
- Autonomous ad-hoc networked devices & participatory surveillance (smart cameras, open architectures, self – calibration, localization & organization)
- Design for privacy (privacy aware systems, automatic face blurring, soft biometrics)

The workshop is on invitation only. From preliminary contacts, it is estimated that around 25-35 persons will attend, representing RTD institutes or academia, operators and leading system / equipment providers, covering quite well the expected objectives and applications cited above. All of the participants are active in a broad range of EU and nationally funded projects. The workshop is expected to generate new ideas and synergies also in view of the upcoming FP7 calls and the setting-up of the EU Common Strategic Framework for Research and Innovation.

The workshop will start at 14:00 of Tuesday July 5 and will conclude at 16:00 of the following day. Entrance in JRC is controlled and requires that you send us data on your nationality, employer, ID or passport No, date and place of birth, at least one week (3 weeks for non-EU nationals) before the workshop. Ispra is conveniently located near the Malpensa airport, the main airport of Milan, Italy. Transport to / from the airport / JRC / hotels, as well as facilitation for hotel reservation will be provided by JRC as long as you provide us your flight / arrival details.

The WS program consists in 11 x 30 min slots, each involving a 15-20 min presentation / introduction and 10-15 min discussions. In addition, a networking session will be dedicated to multi or bi-lateral discussions on future cooperation, potential common project proposals, etc. A preliminary agenda is as follows:

Tuesday July 5

10:00 – 12:30	Arrival of attendees – informal meeting – visit of Ispra site
12:30 – 13:30	Lunch in JRC premises
14:00 – 14:30	Welcome – presentations – introduction
14:30 – 16:00	Operational requirements & standards (3 slots)
16:00 – 16:15	Coffee break
16:15 –17:15	Privacy & data protection (2 slots)
17:30 – 18:00	Transfer to hotels
19:30 – 22:30	Social dinner incl. transfer from / to hotels

Wednesday July 6

08:15 – 08:45	Transfer from hotels to JRC
09:00 – 10:30	Tracking in complex environments (3 slots)
10:30 – 10:45	Coffee break
10:45 – 12:15	Novel systems & architectures (3 slots)
12:15 – 14:00	Lunch
14:00 – 16:00	Discussion and conclusions on eventual collaborations, projects etc.
16:00 – 17:00	Transfer to airport or hotels

The detailed program together with the necessary forms for your entrance permits and airport / hotel shuttle will be communicated early in June.

The JRC has placed an option on hotel rooms in SUNSET hotel, Via al Lido 7, 21026 Gavirate VA, www.sunsethotel.it, Email: info@sunsethotel.it, tel. +39 0332 731023, which should be confirmed through our web based registration system as soon as possible. The price is €85 per night for a single or €130 for a double room, inclusive of breakfast, to be paid by each participant. Lunches, coffee breaks and the social dinner on 5th of July will be offered by JRC.

If you plan to attend then you must register following the instructions on the next page. Filling exactly all the required information will allow us to manage your accommodation, transport and all other services related to the workshop.
Please do not hesitate to contact us on any issue regarding the workshop.

Kind Regards,

Fivos Andritsos
Action Leader

Jean-Pierre Nordvik
Acting Head of Unit

Contacts:

Daniela BURESTA	+39 0332 789515	daniela.buresta@ec.europa.eu
Monica GEMO	+39 0332 783081	monica.gemo@jrc.ec.europa.eu

REGISTRATION INSTRUCTIONS

If you are interested in attending this meeting, please register as soon as possible (and anyway not later than the **deadline of 25 June 2011**) on the JRC Event Registration System website https://jrc-meeting-registration.jrc.ec.europa.eu

The first time you access the site you need to create an account using the link “Create User Account” (top-right of the page). If you already have a user account from the past on this site and forgot your password, just fill in your email address and press on the button “Password Reminder”.

Once you have created your user account, login to the system using the link “Login” (top-right of the page) and select, in the menu "ISPRA" and "July 2011" and "Emerging Surveillance Capabilities and Requirements workshop"

Please read attentively the Privacy statement and accept it by checking at the bottom of the page "I accept the Events registration statement".

For this meeting you also have to check the “Accommodation Required” checkbox and, if you are accompanied by a person, also check the “I’m accompanied” check box.

In the form that comes up you can indicate if you need accommodation in the Sunset Hotel (recommended) or if you organise your own accommodation (in which case you also have to take care for arriving at the JRC premises). If you choose Sunset Hotel from the combobox, also indicate the type of room you want and the check-in and check-out date. If you want there is space to create a small message to be sent to the hotel. If you are accompanied by a non-participant please fill in also the details of this person.

To finalise the registration, click on the “Register” link. Your registration will be accepted (if all data is provided) and you will receive a confirmation email.

You can access your Registration until 25 June 2011 in order to modify and update it. The registration system will be available until then. For registration requests made after that date, JRC cannot guarantee hotel rooms.

For any questions related to the registration please contact:

Ms. **Daniela Buresta** +39-0332-789515 daniela.buresta@ec.europa.eu

Appendix 2: Workshop Agenda

Workshop on Emerging Surveillance Capabilities & Requirements

Agenda

Tuesday, July 5, 2011

Afternoon: JRC Building 36, Room 3

Time	Event/Activity	Speaker
10:30 – 12:30	Arrival of the attendees, informal discussions	
12:30 – 13:30	Lunch in JRC premises	
13:30	Start of the workshop	
13:30 – 14:00	Welcome & introduction	F. ANDRITSOS, JRC IPSC Jean Pierre NORDVIK, JRC IPSC
14:00 – 15:30	**SESSION 1** **Capabilities** **Smart CCTV: More is Not Enough** **Video Analytics The NICE Way** **Current initiatives to drive performance and innovation in video detection systems**	Chair: F.ANDRITSOS, JRC IPSC Sean GONG, Head of Computer Vision Group QMUL, UK Guy LORMAN NICE Systems, IL Stuart RANKIN, Kingsley SAGE Home Office CAST, UK
15:30 – 16:00	Coffee Break	
16:00 – 18:00	**SESSION 2** **Capabillities (cont'd)** **From detection & tracking to the analysis of social behaviour** **Observing people and their behaviours** **Integration of multiple sensor modalities for detecting intruders in wide open areas** **Next-generation communications for pervasive surveillance**	Chair: F.ANDRITSOS, JRC IPSC Vittorio MURINO IIT – UNIVR, IT Andrea CAVALLARO QMUL, UK Rita CUCCHIARA UNIMORE, IT Ozgur Baris AKAN KOÇ University, TR
18:00 – 18:30	**Wrap-up for the first day**	
18:30	Transfer to hotel	
20:00 – 23:00	Social dinner incl. transfer from / to hotel	

Wednesday, July 6, 2011

Morning: JRC Building 36, Room 3

Time	Event/Activity	Speaker
08:00	Hotel pick up, transfer to JRC	
08:30	Start of the Workshop	
08:30 – 10:30	**SESSION 3** **Privacy** **Towards privacy-enabled tracking and people re-identification in multi-Camera systems** **Privacy-by-design and surveillance technologies: challenges and opportunities** **Managing privacy in emerging video surveillance systems** **Privacy Enforcement for Surveillance Systems**	Chair: F.ANDRITSOS, JRC IPSC Eduardo MONARI FRAUNHOFER IOSB, DE Laurent BESLAY EDPS, EU Fanny COUDERT ICRI-KUL, BE Hauke VAGTS FRAUNHOFER IOSB, DE
10:30 – 11:00	Coffee Break	
11:00 – 13:00	**SESSION 4** **Requirements & Standards** **Video-surveillance standardization and expected operational benefits** **A maturing industry depends on standards in engineering surveillance systems** **RATP connecting passengers: deploying operational video analysis in Paris Metro system** **Integrating innovative audio/video analysis tools in CCTV platform for urban transport: Turin and Paris use-cases**	Chair: F.ANDRITSOS, JRC IPSC Jean Francois SULZER THALES, FR Jeroen VAN REST TNO, NL Fabrice SABOURIN RATP, FR Cyril CARINCOTTE MULTITEL, BE
13:00 – 14:00	LUNCHTIME	
14:00 – 16:00	**Discussion on conclusions & eventual follow-up**	
16:00	**End of the workshop – Transfer to Airport**	

List of participating organizations

Austria	Austrian Institute of Technology
Belgium	ICRI - Katholieke Universiteit Leuven Multitel Research Centre
France	RATP Group THALES
European Union	European Data Protection Supervisor (EDPS) Joint Research Centre (JRC) JRC's Institute for the Protection and the Security of Citizen (IPSC)
Germany	Robert Bosch GmbH, Corp. Research Fraunhofer IOSB
Israel	NICE Systems
Italy	Azienda Trasporti Milano ATM Istituto Italiano di Tecnologia (IIT) Italian Coast Guard Head Quarters Politecnico di Milano, Universita di Modena e Reggio Emilia
Netherlands	Netherlands Organization for Applied Scientific Research (TNO)
Sweden	Axis Communications AB
Turkey **United Kingdom**	Koç University Home Office - Centre for Applied Science and Technology (CAST) Ministry of Defense Queen Mary University of London University of Reading, School of Systems Engineering Whiteknights

List of Acronyms

AIT	Austrian Institute of Technology
ATM	Azienda Trasporti Milano
CAST	Home Office - Centre for Applied Science and Technology
ICRI	Interdisciplinary Centre for Law & ICT - Katholieke Universiteit Leuven
IOSB	Fraunhofer-Institut für Optronik, Systemtechnik und Bildauswertung
EDPS	European Data Protection Supervisor
JRC	Joint Research Centre
JRC-IPSC	JRC's Institute for the Protection and the Security of Citizen
MoD	Ministry of Defense
QMUL	Queen Mary University of London
RATP	Régie Autonome des Transports Parisiens
TNO	Netherlands Organization for Applied Scientific Research

Appendix 3: List of Participants

Workshop Emerging Surveillance Capabilities & Requirements, Ispra 5 – 6 July 2011					
	Name	**Surname**	**Company**	**State**	**Email**
1	Ozgur Baris	**Akan**	Koc University	TR	*akan@ku.edu.tr*
2	Robert	**Alabrese**	EC – Joint Research Centre	IT	*robert.alabrese@ec.europa.eu*
3	Fivos	**Andritsos**	EC – Joint Research Centre	IT	*fivos.andritsos@jrc.ec.europa.eu*
4	Gianmarco	**Baldini**	EC – Joint Research Centre	IT	*gianmarco.baldini@jrc.ec.europa.eu*
5	Laurent	**Beslay**	European Data Protection Supervisor	BE	*laurent.beslay@edps.europa.eu*
6	Lothar	**Breitenbach**	EC – Joint Research Centre	IT	*lothar.breitenbach@jrc.ec.europa.eu*
7	Cyril	**Carincotte**	Multitel Research Centre	BE	*carincotte@multitel.be*
8	Andrea	**Cavallaro**	Queen Mary University	UK	*andrea.cavallaro@eecs.qmul.ac.uk*
9	Michel	**Chiaramello**	EC – Joint Research Centre	IT	*michel.chiaramello@jrc.ec.europa.eu*
10	Fanny	**Coudert**	ICRI - Katholieke Universiteit Leuven	BE	*fanny.coudert@law.kuleuven.be*
11	Rita	**Cucchiara**	Universita di Modena e Reggio Emilia	IT	*rita.cucchiara@unimore.it*
12	Roberto	**Daverio**	EC – Joint Research Centre	IT	*roberto.daverio@jrc.ec.europa.eu*
13	Andrew	**Eagle**	Ministry of Defence	UK	*andrewe@cisa.gsi.gov.uk*
14	James	**Ferryman**	University of Reading	UK	*james@computer.org*
15	Monica	**Gemo**	EC – Joint Research Centre	IT	*monica.gemo@jrc.ec.europa.eu*
16	Shaogang Sean	**Gong**	Queen Mary University	UK	*sgg@eecs.qmul.ac.uk*
17	Ted	**Hartzel**	AXIS Communications	SE	*tedh@axis.com*
18	Fredrik	**Hertzberg**	AXIS Communications	SE	*fredrik.hertzberg@axis.com*
19	Michael	**Hoeynck**	BOSCH	DE	*michael.hoeynck@bosch.com*
20	Collin	**Lewis**	Home Office CPNI	UK	*colin.sa2@btopenworld.com*
21	Guy	**Lorman**	NICE	IL	*guy.lorman@nice.com*
22	Jean Pierre	**Nordvik**	EC – Joint Research Centre	IT	*jean-pierre.nordvik@jrc.ec.europa.eu*
23	Stefano	**Milanesi**	ATM Milano	IT	*stefano.milanesi@atm-mi.it*
24	Eduardo	**Monari**	IOSB Fraunhofer	DE	*eduardo.monari@iosb.fraunhofer.de*
25	Vittorio	**Murino**	Istituto Italiano di Tecnologia	IT	*vittorio.murino@iit.it*
26	Claudio	**Pantaleo**	ATM Milano	IT	*claudio.pantaleo@atm-mi.it*
27	Julien	**Pepinster**	RATP Group	FR	*julian.pepinster@ratp.fr*
28	Stuart	**Rankin**	Home Office	UK	*stuart.rankin@homeoffice.gsi.gov.uk*
29	Fabrice	**Sabourin**	RATP Group	FR	*fabrice.sabourin@ratp.fr*
30	Kinsley	**Sage**	Home Office	UK	*kingsley.sage2@homeoffice.gsi.gov.uk*
31	Panagiotis	**Sotiropoulos**	EC – Joint Research Centre	IT	*panagiotis.sotiropoulos@jrc.ec.europa.eu*
32	Bernard	**Strobl**	Austrian Institute of Technology	AT	*bernhard.strobl@ait.ac.at*
33	Jean-francois	**Sulzer**	THALES	FR	*jean-francois.sulzer@thalesgroup.com*
34	Vasileios	**Syrris**	EC – Joint Research Centre	IT	*vasileios.syrris@jrc.ec.europa.eu*
35	Stefano	**Tubaro**	Politecnico di Milano	IT	*stefano.tubaro@polimi.it*
36	Andrea	**Usai**	EC – Joint Research Centre	IT	*andrea.usai@jrc.ec.europa.eu*
37	Hauke	**Vagts**	IOSB Fraunhofer	DE	*hauke.vagts@iosb.fraunhofer.de*
38	Jeroen	**Van rest**	TNO	NL	*jeroen.vanrest@tno.nl*

Appendix 4: Workshop Presentations

Workshop Introduction

Session 1: Capabilities

Session 2: Capabilities (cont'd)

Session 3: Privacy

Session 4: Requirements and Standards

Closing Session

Workshop Introduction

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Emerging Surveillance Capabilities & Requirements

Workshop, JRC Ispra, July 5-6, 2011

Welcome & introduction

F. Andritsos

Slide 1 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Contents

Workshop scope & agenda

Who we are

SURCIT: a new action

Ad-hoc networked cameras for emergency response, 2 paradigms:

- **LOCCATEC project**
- **ASPIS project**

Slide 2 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Workshop scope & expectations

- Review the **technology state of the art** and the **operational requirements**
- Anticipate **technology trends** and **future needs**
- Consider legal, regulatory and ethical aspects

Fields:

- Tracking in complex, cluttered environments
- Autonomous ad-hoc networked devices & participatory surveillance
- Design for privacy

→ *Create / consolidate **networking & synergies***

→ *Explore **partnerships** in future EU proposals*

Slide 3 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Workshop agenda – 1st session: Capabilities

14:00 – 14:30 **Presentation and demo on multi-camera identification and tracking** (Sean Gong - QMUL)

14:30 – 15:00 **Video Analytics capabilities** (Guy Lorman - NICE)

15:00 – 15:30 **Current Initiatives to drive performance and innovation in video detection systems** (Stuart Rankin and Kingsley Sage - HOSDB)

15:30 – 16:00 Coffee break

Slide 4 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Workshop agenda – 2nd session: Capabilities

16:00 – 16:30	**From detection and tracking to the analysis of social behaviour** (Vittorio Murino - IIT/UNIVR)
16:30 – 17:00	**Observing people and their behaviours** (Andrea Cavallaro - QMUL)
17:00 – 17:30	**Integration of multiple sensor modalities for detecting intruders in wide open areas** (Rita Cucchiara - UNIMORE)
17:30 – 18:00	**Next-generation communications for pervasive surveillance** (Ozgur Akan - KOÇ)
18:00 – 18:30	Wrap-up for the 1st day
18:30 – 19:00	Transfer to hotel
20:00 – 23:00	**Social dinner**

Slide 5 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Workshop agenda – 3rd session: Privacy

08:00	Transfer from hotel to JRC
08:30 – 09:00	**Privacy-by-design and surveillance technologies: challenges and opportunities** (Laurent Beslay - EDPS)
09:00 – 09:30	**Managing privacy in emerging video surveillance systems** (Fanny Coudert – ICRI/KUL)
09:30 – 10:00	**Towards privacy-enabled tracking and people re-identification in multi-camera systems** (Eduardo Monari - IOSB)
10:00 – 10:30	**Privacy enforcement for surveillance systems** (Hauke Vagts - IOSB)
10:30 – 11:00	Coffee break

Slide 6 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Workshop agenda – 4th session: Requirements & standards

11:00 – 11:30 **Video-surveillance standardization and expected operational benefits** (Jean François Sulzer - THALES)

11:30 – 12:00 **A maturing industry depends on standards in engineering surveillance systems** (Jeroen Van Rest - TNO)

12:00 – 12:30 RATP connecting passengers **Deploying operational video analysis in Paris Metro system** (Fabrice Sabourin - RATP)

12:30 – 13:00 **Integrating innovative audio/video analysis tools in CCTV platform for urban transport: Turin and Paris use-cases** (Cyril Carincotte - MULTITEL)

Slide 7 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Closing session

13:00 – 14:00 Lunch

14:00 – 16:00 **Discussion on conclusions and eventual follow-up measures (All)**

16:00 End of the workshop
Transfer to airport or hotel

Slide 8 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Where does the JRC fit in the European Commission?

President Barroso — 27 Commission Members

Commissioner Geoghegan-Quinn
Research, Innovation & Science

Joint Research Centre (JRC) — Research DG (RTD)

Slide 9

Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Our Structure: 7 Institutes in 5 Member States

IRMM – *Geel, Belgium*
Institute for Reference Materials and Measurements

ITU – *Karlsruhe, Germany*
Institute for Transuranium Elements

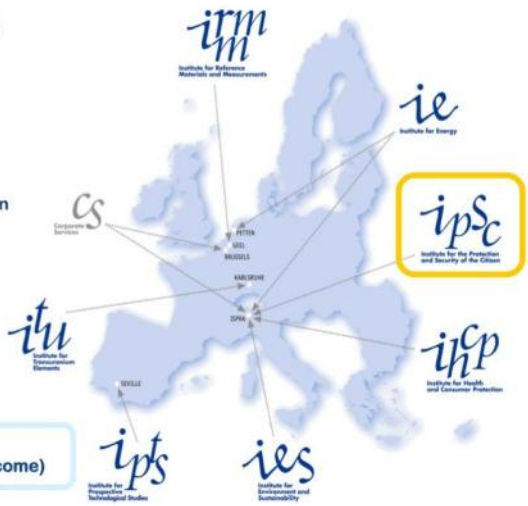
IE – *Petten, The Netherlands and Ispra, Italy*
Institute for Energy

IPSC – *Ispra, Italy*
Institute for the Protection and Security of the Citizen

IES – *Ispra, Italy*
Institute for Environment and Sustainability

IHCP – *Ispra, Italy*
Institute for Health and Consumer Protection

IPTS – *Seville, Spain*
Institute for Prospective Technological Studies



~ 2750 staff
~ 345 M€/y institutional budget (+ 60 M€/y earned income)

Slide 10

Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

7th Framework Programme (FP7) Institutional funding

SEVENTH FRAMEWORK PROGRAMME

Non-nuclear programme

2007-2013

1,751 M€

EURATOM programme

2007-2011

517 M€

FP7 indirect actions

Collaboration with national public and private research institutes, academia, industry and international bodies

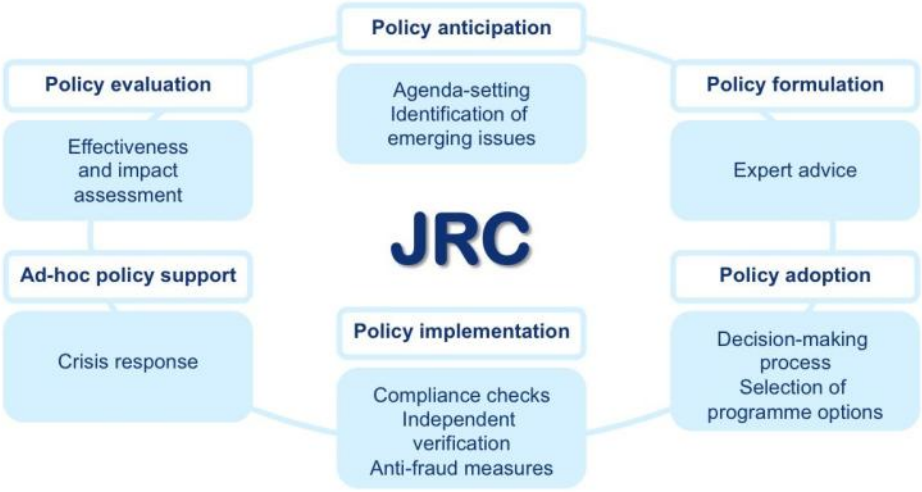
Slide 11

Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

JRC's Mission in the Policy Cycle



Slide 12

Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

JRC Strategy 2010-2020

Strategic Developments

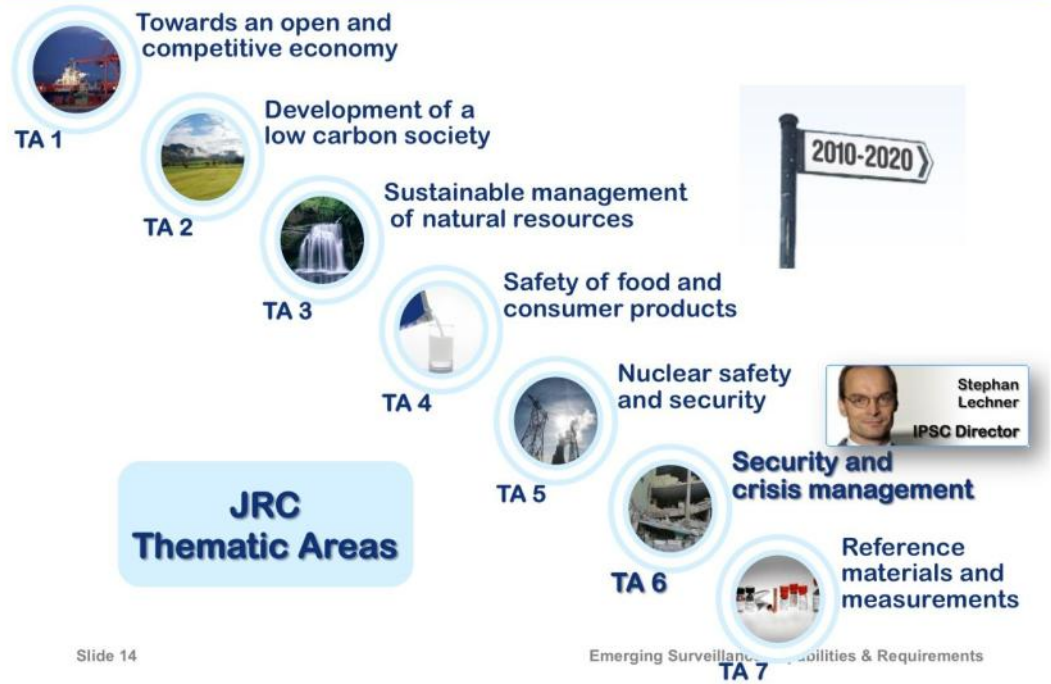
- Socio-economic research and modelling capacity will be expanded
- Multi-disciplinary research teams across the JRC
- Strong proactive forward-looking, horizon scanning capacity
- Enhanced assessment of policy options
- Seven Thematic Areas

Slide 13

Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen



Slide 14

Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

JRC in the European Research Area

Collaboration with over 1,000 public and private organisations, institutions and expert groups in more than 250 major networks

- Cooperation and partnerships with key organisations
- Support to enlargement
- Training and mobility of researchers
- Access to scientific infrastructures
- Support to ERA policies
- Support to standardisation

European Research Area

Slide 15 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

The people of JRC

Staff breakdown 2009

Slide 16 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Digital Citizen's Security – IPSC unit

Security ethics
Electronic traces
Profiling

Data Protection
Privacy
Acceptance of emerging ICTs

Focus → **Security and safety impact of new information and communication technologies (ICT) on the citizen**

Objectives → **Broaden the technological approach to societal and legal dimensions**
Focus on the citizen and his/her perception
Assess the implications

Impact → **EU 2020 Digital Agenda** (e.g. EU data protection framework)
Citizens rights (security vs. privacy)
Europe in the world (e.g. data sharing with third countries)

Slide 17 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

SURCIT action

Novel intelligent, efficient and secure surveillance systems that will increase the safety and security of EU citizens without compromising their fundamental rights for privacy

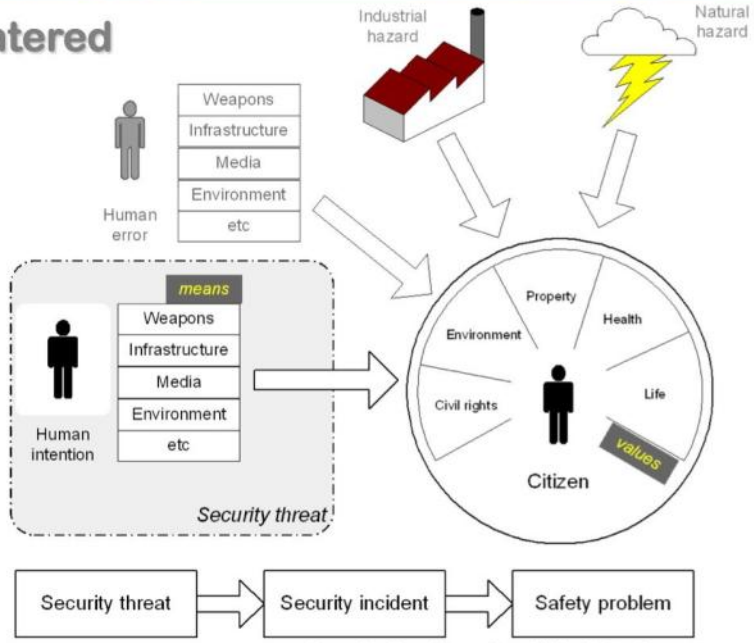
- Systemic analysis: definitions, terms of reference, societal requirements, within a **Citizen Centred framework**;
- **State-of-the-art** of surveillance / monitoring ICT systems; new generation surveillance technologies / systems
- Functional **standards / specifications**, guidelines or best practices regarding the development and use of such systems.

Slide 18 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Citizen centered approach



JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

SURCIT - past

Former RAV (requirement analysis & verification)

Novel IT systems for remote inspection, monitoring and intervention

- **System's analysis, focused on: requirements analysis, functional specifications and verification**
- **Mostly competitive / collaborative projects**
- **Build expertise though collaboration in RTD projects**
- **Significant expertise in a wide range of technologies and applications**

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

SURCIT - 2011 objectives

Systemic analysis of surveillance within a Citizen Centred framework

- Comprehensive set of definitions & terms of reference
- State-of-the-art of surveillance / monitoring ICT systems
- Identification and classification of the main actors
- Plan for the next 4-5 yrs

→ Workshop by mid-2011

Slide 21 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

SURCIT - 2011 objectives

Pursue collaborative / competitive activities

- Complete ASPIS
- Proceed with SECURED
- New proposals

- MoU with UK Home Office
- Collaboration with Fraunhofer
- Collaboration with Koç University
- ……..

Slide 22 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

SURCIT - future

Candidate research areas:

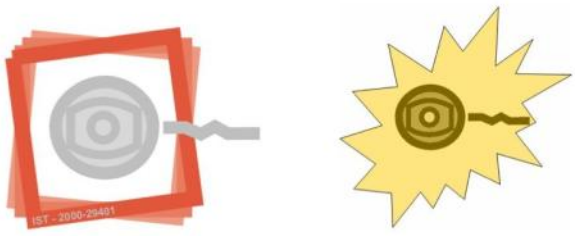
- Pervasive / participatory surveillance & autonomous ad-hoc networked devices
- Design for privacy
- Multi-camera surveillance and tracking,
- GIS integration of surveillance / geo-location & tracking
- .....

Slide 23

Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen



Conditional autonomous surveillance

LOCCATEC & **ASPIS**

FP5 IST
completed in 2006

FP7 SST
started mid 2008

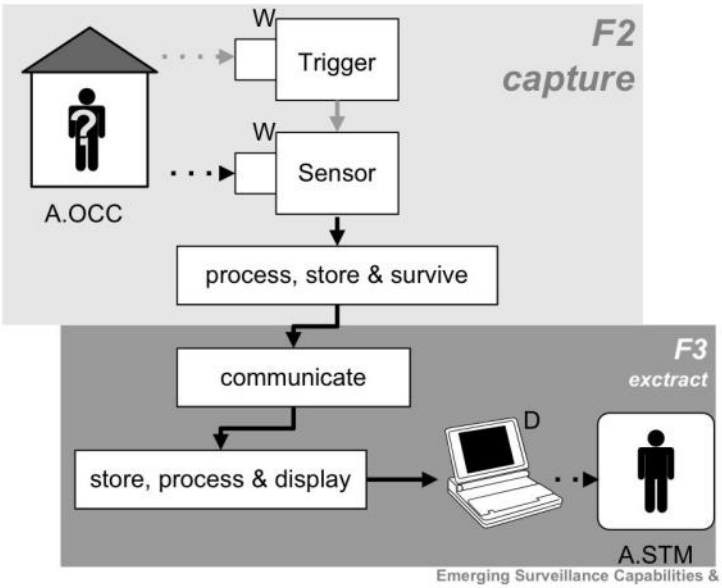
Slide 24

Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

LOCCATEC principle



Slide 25
Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

LOCCATEC - technological issues

Triggering

Collapse anticipation
Low-cost but reliable solution
- Some false triggering can be tolerated
- Near 100% fail-safe → no collapse missed

Wireless Communications

Highly cluttered, unpredictable environment
Signal fading / attenuation in reinforced concrete structures
Power & time limitations

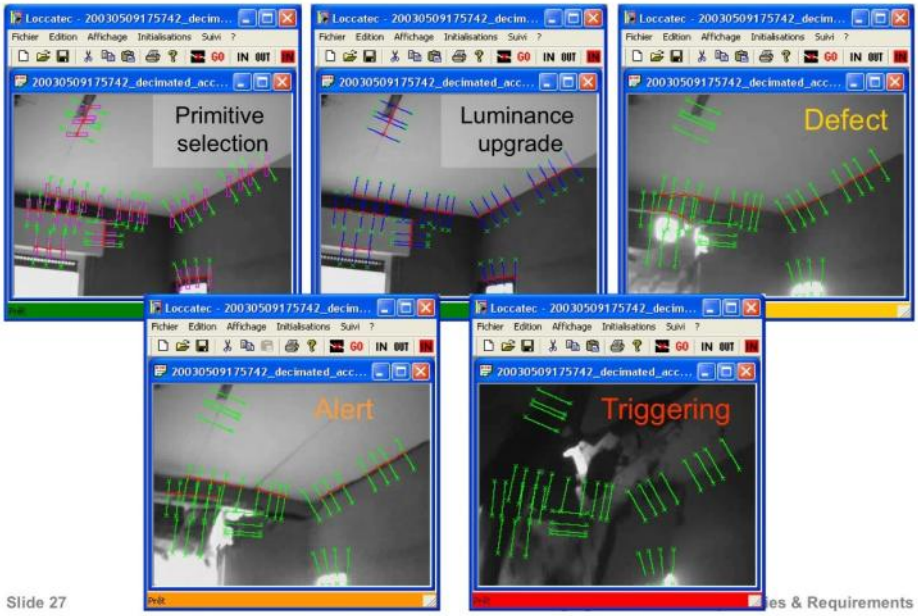
Slide 26
Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION

SURCIT

Institute for the Protection and Security of the Citizen — Surveillance Technologies & the Citizen

LOCCATEC triggering algorithm



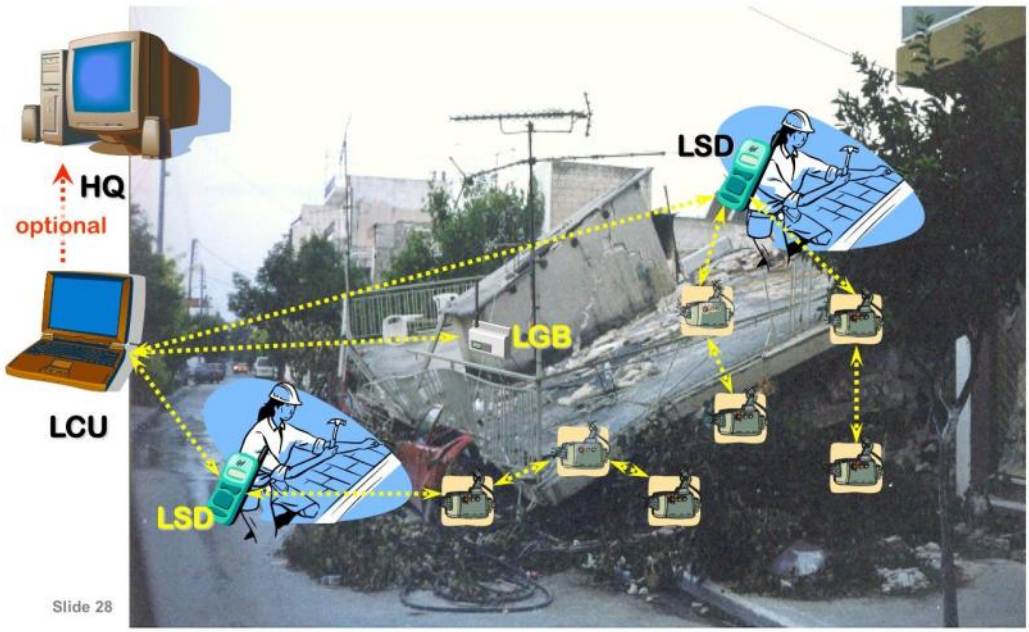
Slide 27

JRC EUROPEAN COMMISSION

SURCIT

Institute for the Protection and Security of the Citizen — Surveillance Technologies & the Citizen

LOCCATEC ad-hoc network



Slide 28

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

LOCCATEC prototype device

Industrial device
anticipated

Slide 29

Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

LOCCATEC central unit

Slide 30

JRC EUROPEAN COMMISSION

SURCIT

Institute for the Protection and Security of the Citizen | Surveillance Technologies & the Citizen

LOCCATEC GUI

Slide 31 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION

SURCIT

Institute for the Protection and Security of the Citizen | Surveillance Technologies & the Citizen

Acknowledgements

The **LOCCATEC** project has been financed by the European Commission under the IST scheme; it started on September 2001 and has concluded on June 2005. The partners who collaborated and invested to develop the LOCCATEC prototype system are:

- IES Solutions, Italy
- Joint Research Centre, European Commission
- Commissariat à l'Energie Atomique, France
- Industrial Systems' Institute, Greece
- ZENON s.a., Greece
- Earthquake Planning & Protection Organization, Greece
- Università della Calabria, Italy

Slide 32 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

ASPIS - scope

Scalable, highly modular, unattended surveillance/ alarm system for public spaces:

1. **Anticipated threats** to public safety: security incidents, accidental events, natural hazards
2. **Monitored spaces**: buildings, trains, buses and other public transport

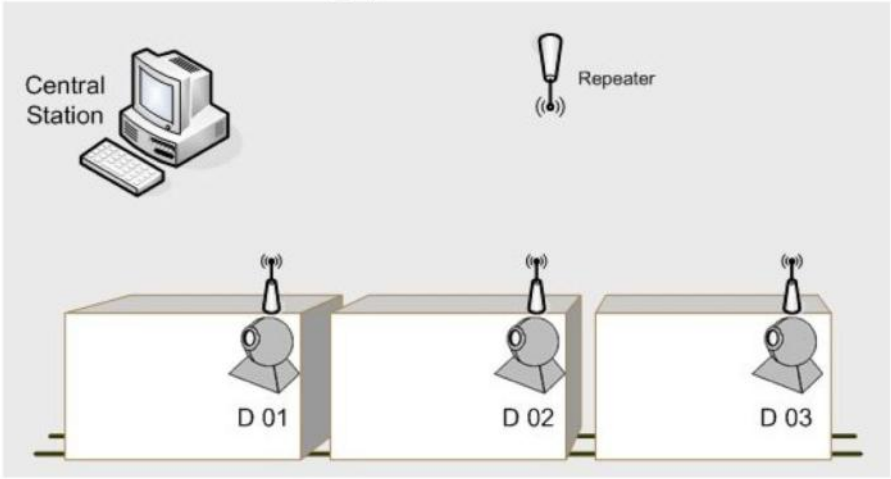
Concept developed, validated and demonstrated through the implementation of a complete prototype system aimed to the public transport (specifically to train or metro) in the event of an explosion or a fire, accidental or intentional.

Slide 33 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

ASPIS – monitoring phase



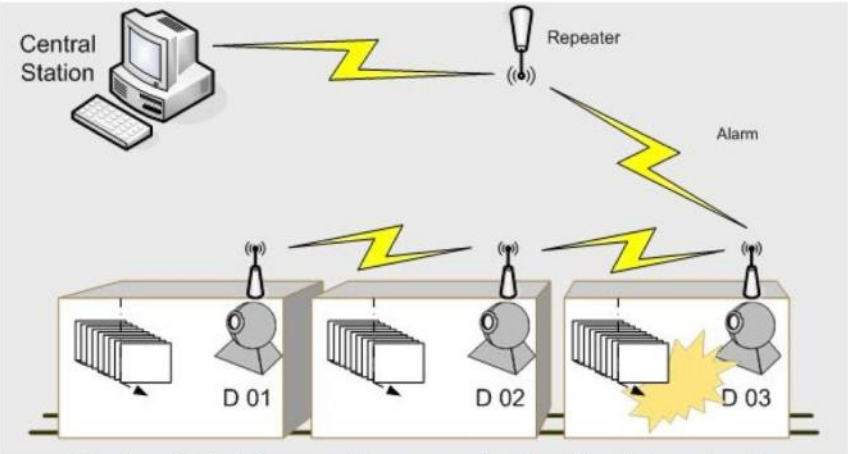
Devices 01, 02 and 03 are ready to be triggered; no information is retained or transmitted anywhere

Slide 34 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

ASPIS – alarm phase



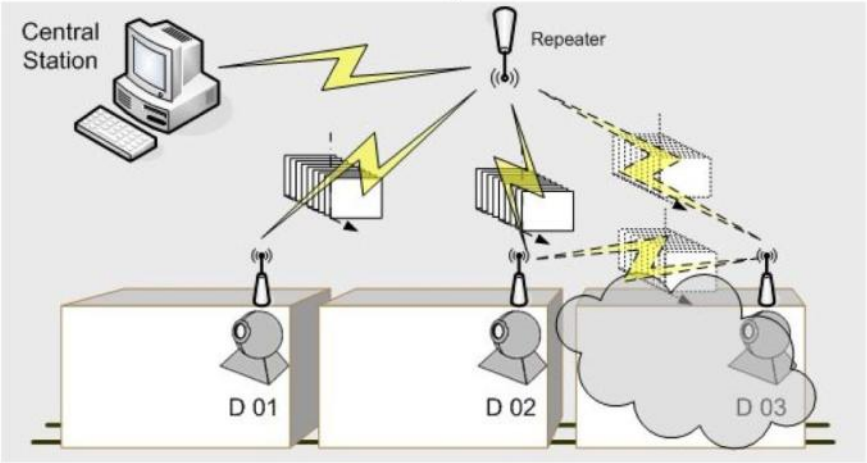
Device 03 is triggered by an explosion; the triggering is propagated to devices 01 and 02 while an alarm is sent to the central station via one or more repeaters; the cyclic buffer of all 3 devices is frozen so that the last XX pictures are kept in memory

Slide 35 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

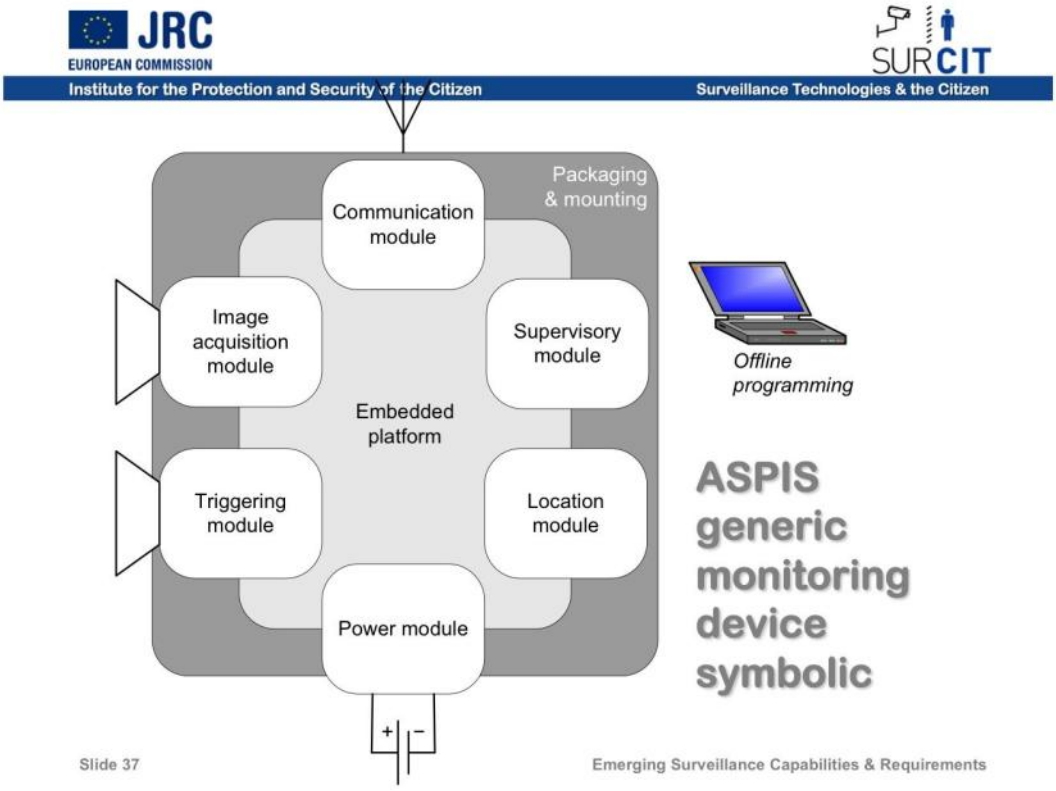
SURCIT
Surveillance Technologies & the Citizen

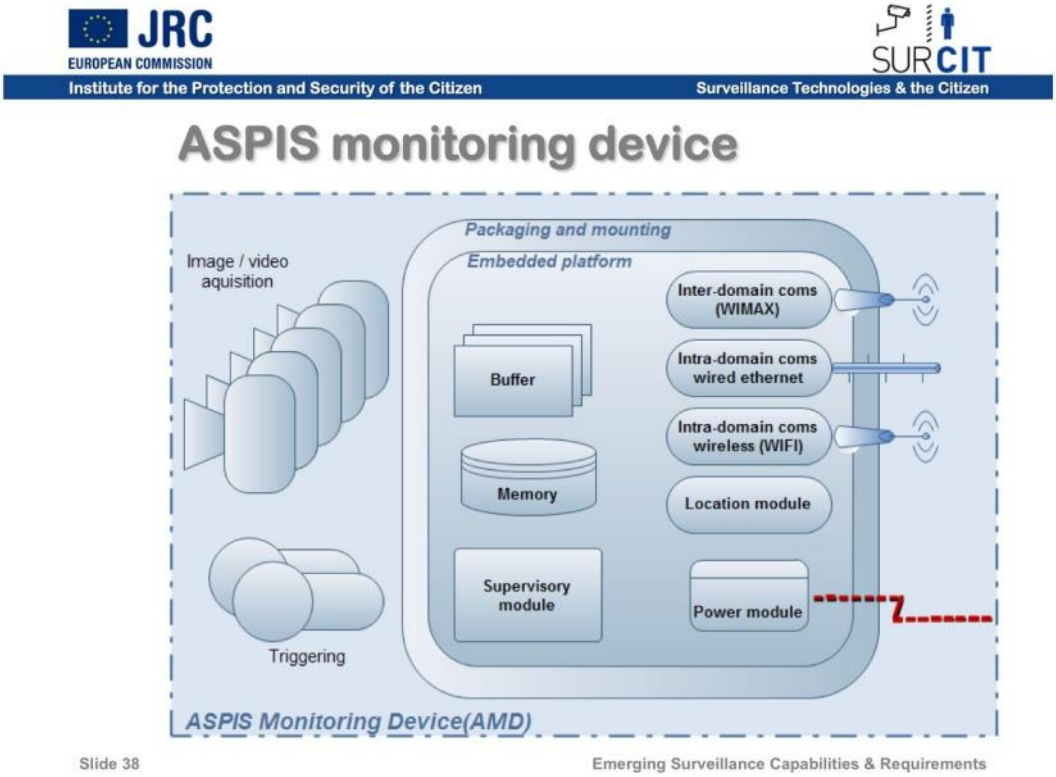
ASPIS – communication phase

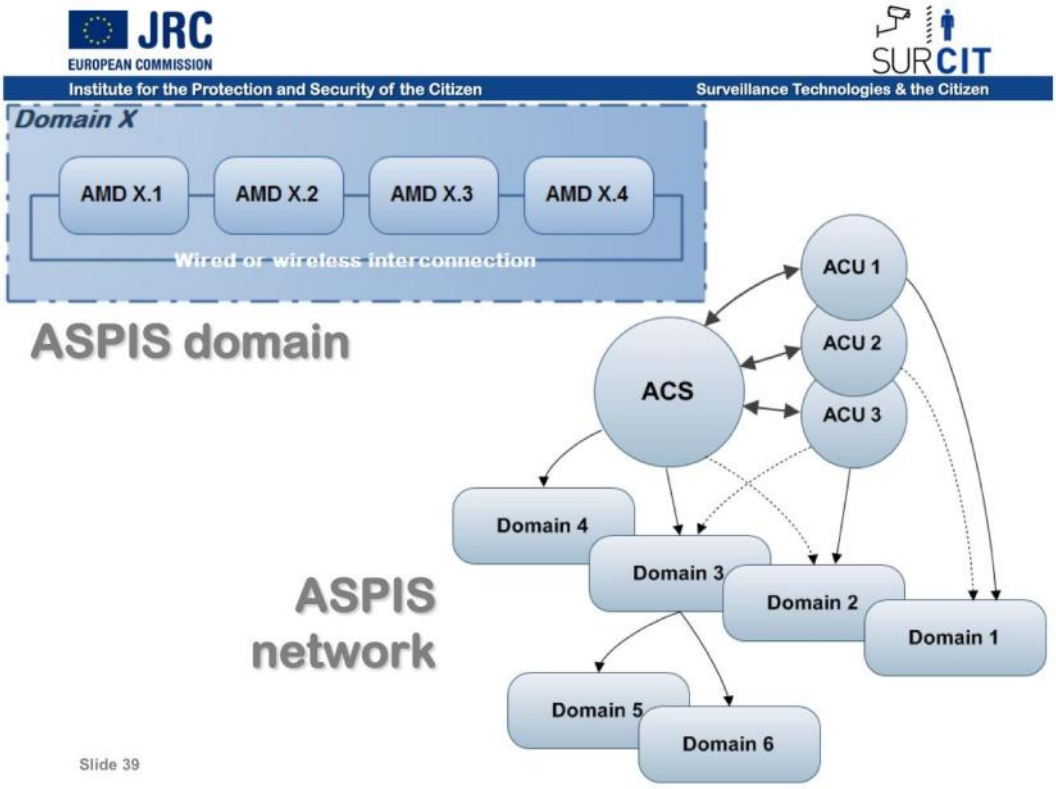


Each triggered device tries to upload its captured data to the central station either directly or indirectly, through repeaters or through neighbouring devices in an ad-hoc network configuration

Slide 36 Emerging Surveillance Capabilities & Requirements


JRC
EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen
SURCIT
Surveillance Technologies & the Citizen
Packaging & mounting
Communication module
Image acquisition module
Supervisory module
Embedded platform
Triggering module
Location module
Power module
+
–
Offline programming
ASPIS generic monitoring device symbolic
Slide 37
Emerging Surveillance Capabilities & Requirements


JRC
EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen
SURCIT
Surveillance Technologies & the Citizen
ASPIS monitoring device
Packaging and mounting
Embedded platform
Image / video aquisition
Inter-domain coms (WIMAX)
Intra-domain coms wired ethernet
Intra-domain coms wireless (WIFI)
Buffer
Memory
Location module
Supervisory module
Power module
Triggering
ASPIS Monitoring Device(AMD)
Slide 38
Emerging Surveillance Capabilities & Requirements


JRC
EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen
SURCIT
Surveillance Technologies & the Citizen
Domain X
AMD X.1
AMD X.2
AMD X.3
AMD X.4
Wired or wireless interconnection
ASPIS domain
ACU 1
ACU 2
ACU 3
ACS
Domain 4
Domain 3
Domain 2
Domain 1
Domain 5
Domain 6
ASPIS network
Slide 39


JRC
EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen
SURCIT
Surveillance Technologies & the Citizen
Acknowledgements
The ASPIS project has started on June 2008, financed under the FP7-SST scheme. Two pilot cases are foreseen:
• RATP (Paris metro) &
• ANEK lines ferries serving the Ancona - Patras route
THALES
EUROPEAN COMMISSION
DIRECTORATE-GENERAL
Joint Research Centre
HELLENIC AEROSPACE INDUSTRY S.A.
RER M T BUS
COMPUTER TECHNOLOGY INSTITUTE
ANEK LINES
i.S.i.
Industrial Systems Institute
CTI
itti
The ASPIS consortium

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Thank you for your attention!

Fivos ANDRITSOS
fivos.andritsos@jrc.ec.europa.eu

Joint Research Centre
Institute for the Protection & Security of the Citizen
SURCIT action

Session 1: Capabilities

Smart CCTV: More is Not Enough

Sean GONG,
Head of Computer Vision Group QMUL, UK

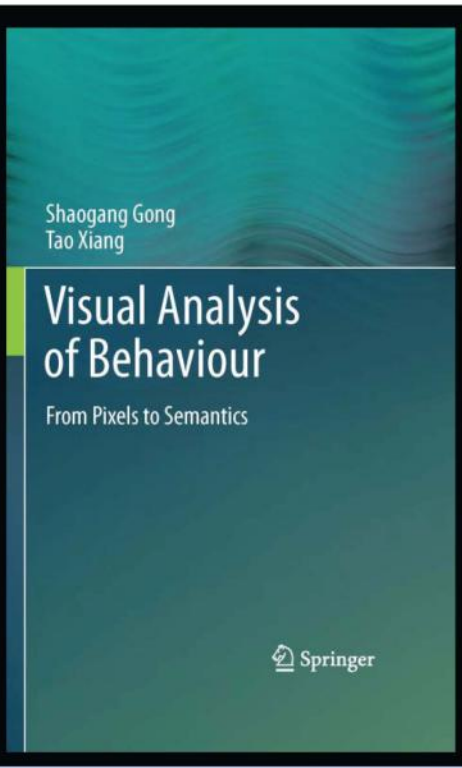
Smart CCTV: More is Not Enough

Sean Gong

Professor of Visual Computation
Head of Computer Vision Group
Queen Mary University of London

vision semantics

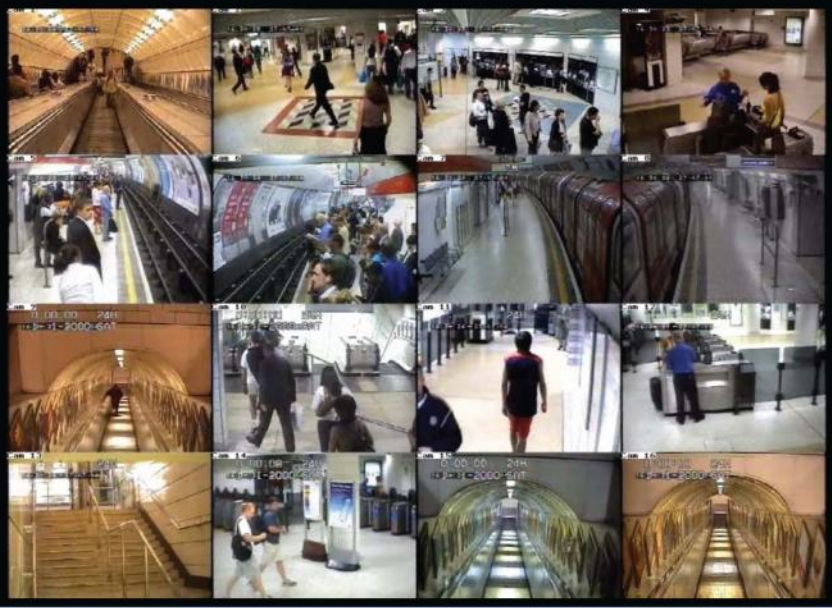
Queen Mary University of London



vision semantics

Queen Mary University of London

CCTV Control Room: Where & What to Look For ?



vision semantics

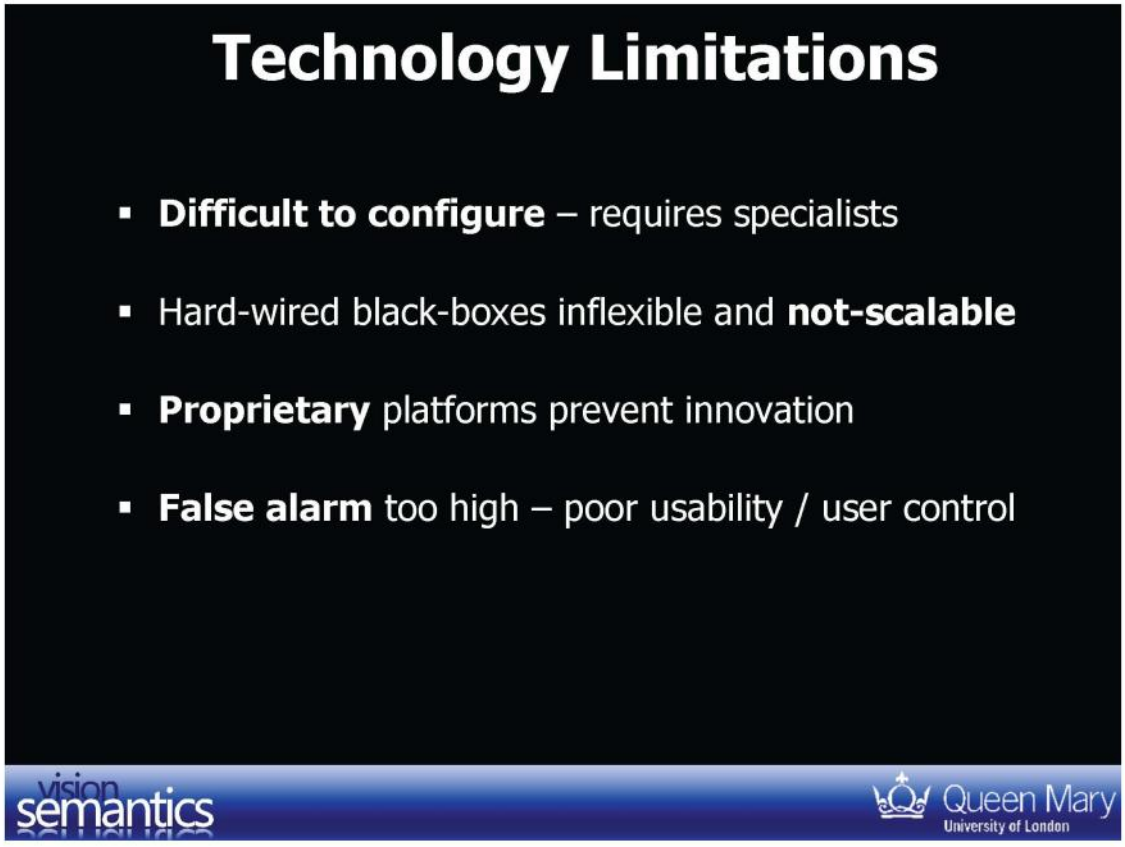
Queen Mary University of London

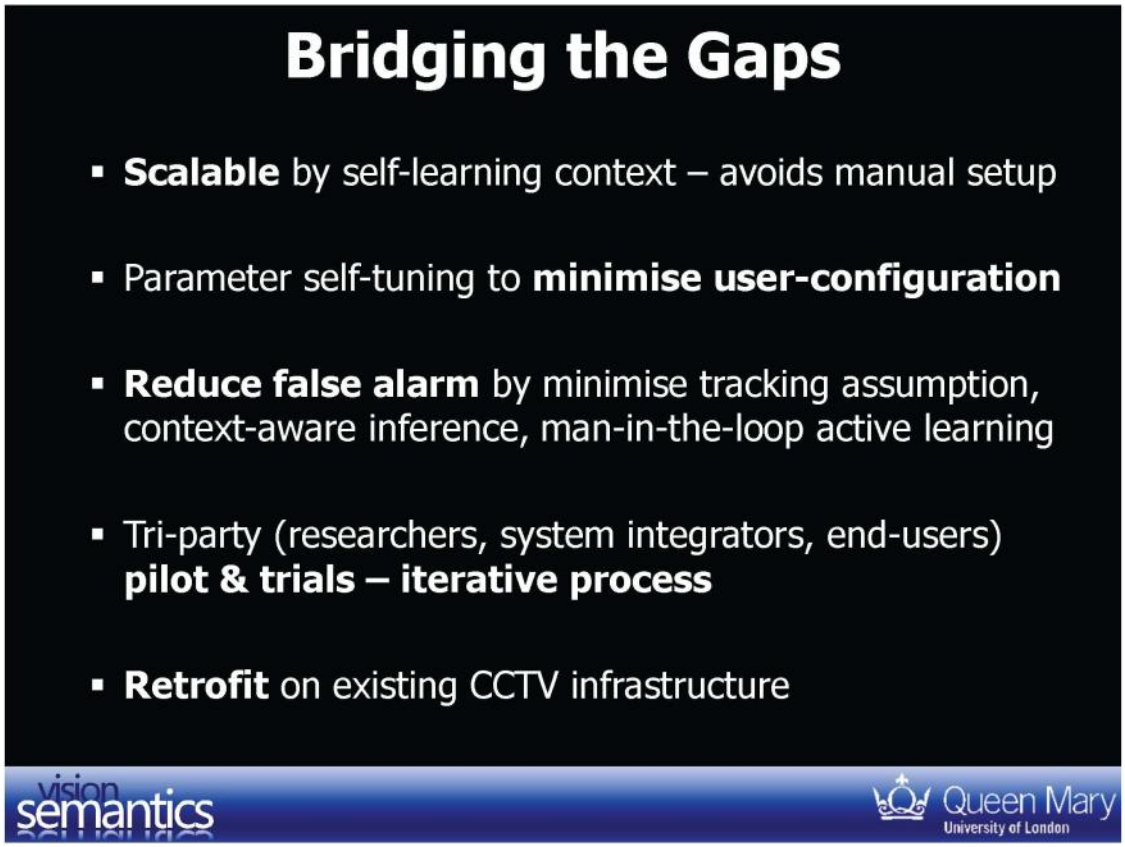
Visual Surveillance: Challenges

- Data overload – lack focus of attention
- Short human attention-span (< 20min)
- Misdetection and inconsistency
- Unknown behaviours of significance
- Lack of global awareness
- Lack of multi-camera coherent understanding

vision semantics

Queen Mary University of London


Technology Limitations
Difficult to configure – requires specialists
Hard-wired black-boxes inflexible and not-scalable
Proprietary platforms prevent innovation
False alarm too high – poor usability / user control
vision semantics
Queen Mary University of London


Bridging the Gaps
Scalable by self-learning context – avoids manual setup
Parameter self-tuning to minimise user-configuration
Reduce false alarm by minimise tracking assumption, context-aware inference, man-in-the-loop active learning
Tri-party (researchers, system integrators, end-users) pilot & trials – iterative process
Retrofit on existing CCTV infrastructure
vision semantics
Queen Mary University of London

EPSRC/MOD BEWARE

Behaviour based Enhancement of Wide-Area Situational Awareness in a Distributed Network of CCTV Cameras

- UK Fighting Crime Increasing Security Programme
- 2007-2011 (EPSRC, MOD), 2008-2012 (MOD, CPNI)
- Partners:
  - Queen Mary University of London (Lead)
  - MOT DSTL, SA/SD, CPNI
  - Home Office HOSDB
  - Vision Semantics
  - Ultra Electronics
  - Portsmouth City Council
  - Smart CCTV

vision semantics

Queen Mary University of London

BEWARE Objectives

1. **Multi-camera tracking of individuals** over different sites
2. **Global behaviour inference** for situational awareness via detecting global abnormal behaviours across multi- cameras
3. **Behaviour driven relevance selection** for on-the-fly selection of viewpoint and regions of interest in a global context across multiple cameras.

vision semantics

Queen Mary University of London

EU FP7 SAMURAI

Suspicious and Abnormal behaviour Monitoring Using a networK of cAmeras for sItuation awareness enhancement

- European Commission Framework 7 Security Programme
- 2008-2011
- Consortium of 8 partners across 5 EU countries
- Led by Queen Mary University of London
- www.samurai-eu.org

vision semantics

Queen Mary University of London

SAMURAI Objectives

- **Networked heterogeneous sensors** of fixed CCTV, wearable cameras, Wi-Fi positioning sensors
- **Object detection & categorisation in crowded spaces** (people, luggage and vehicles)
- **Multi-camera re-identification** over disjoint views
- **"Man-in-the-Loop"** weakly-supervised & active behaviour learning
- **Global behaviour analysis**: From single view to global correlation
- **A `Big Picture'**: Global data fusion and visualisation

vision semantics

Queen Mary University of London

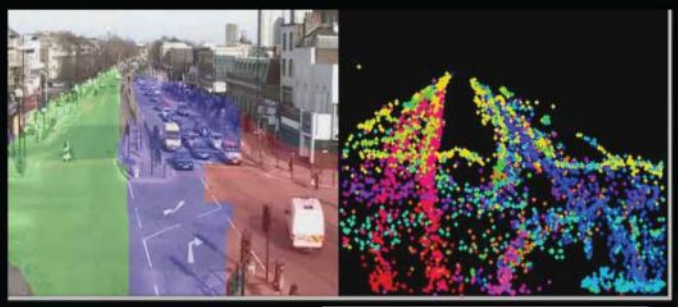
Advances in Computer Vision & Machine Learning

- Learning context from data (Activity-centred data mining)
- Anomaly detection (Context-Aware Correlation)
- Discovering unknown (Behaviour Profiling & Prediction)
- Rare event discovery (Weakly Supervised Learning)
- Human-in-the-loop (Active Learning)
- Multi-camera tracking (Transfer Learning)
- Intention inference (From Action to Body Language Models)
- Global situation awareness (Holistic Space/Time Correlation)

vision semantics

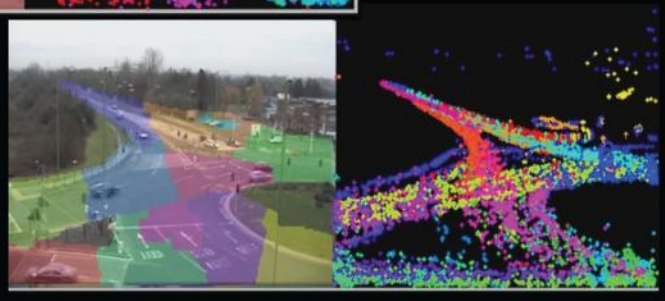
Queen Mary University of London

Self-Learning Activity Context



Learning behavioural context

(Probabilistic Latent Semantic Analysis)

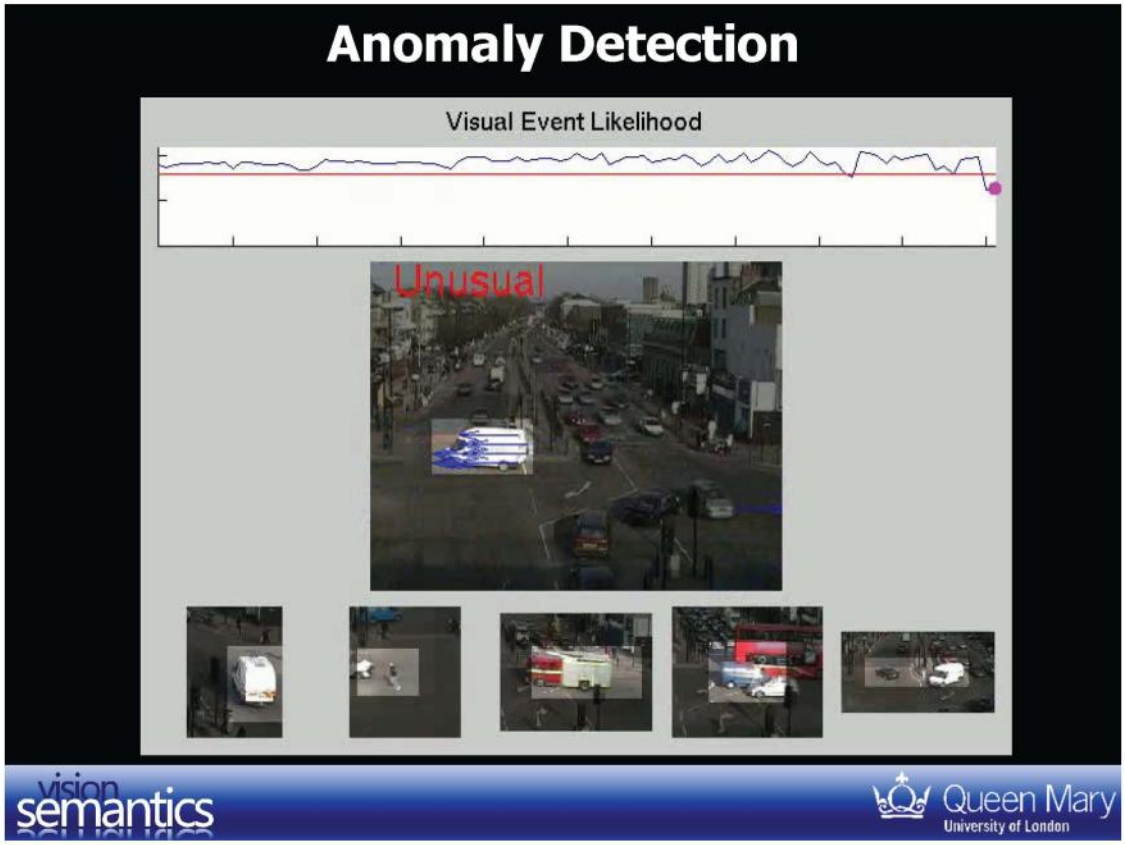


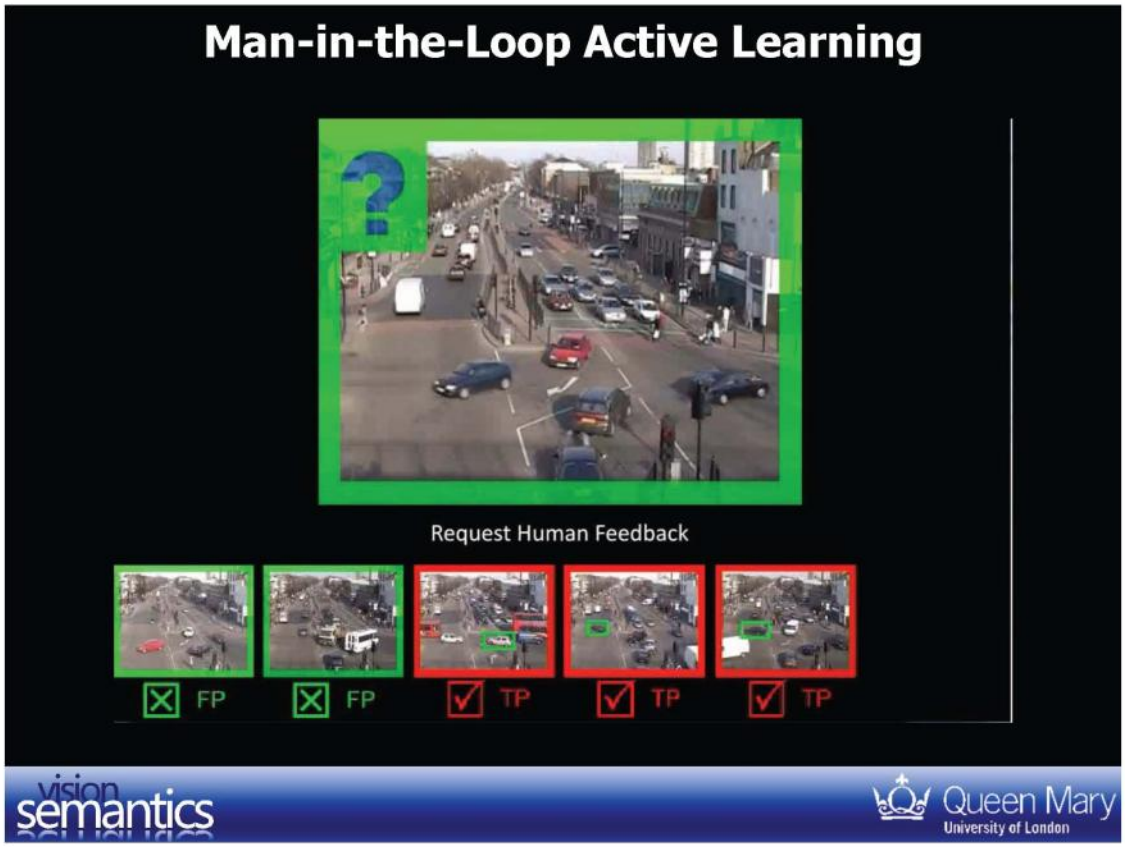
Anomaly detection by contextual-data association

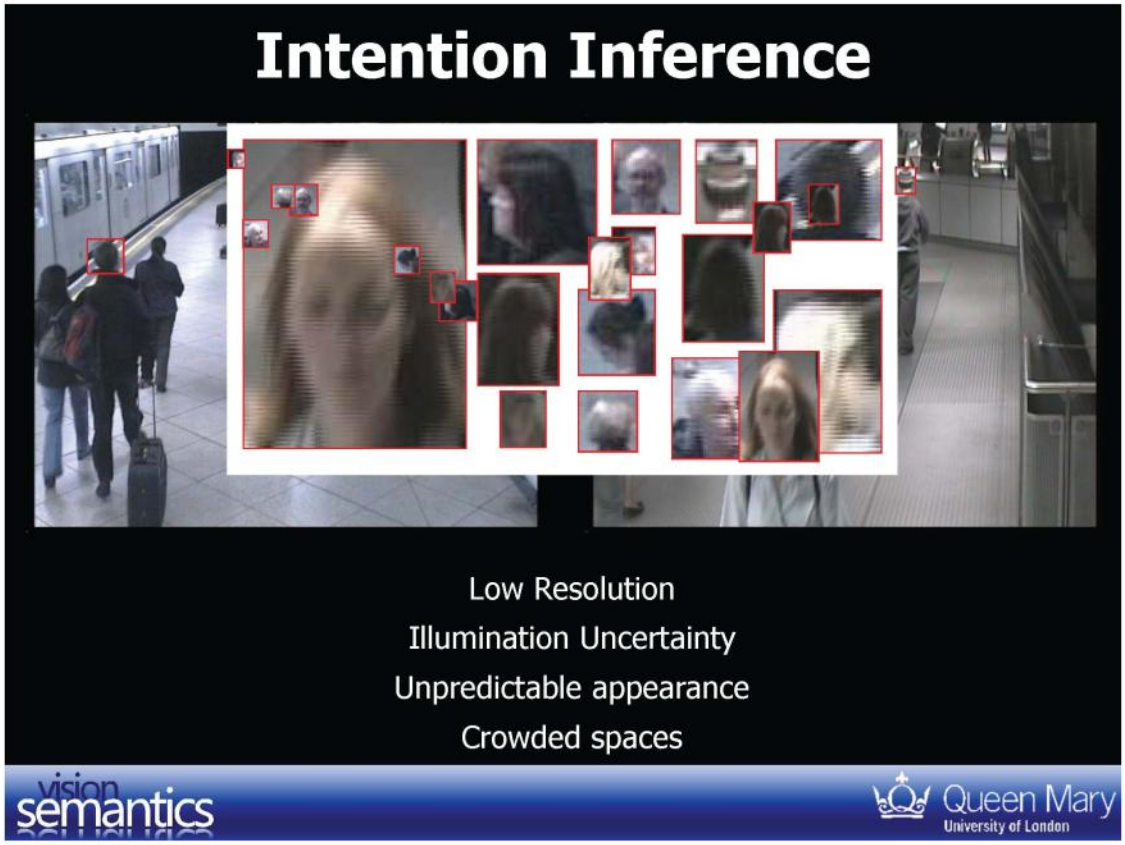
(Markov Clustering Topic Model)

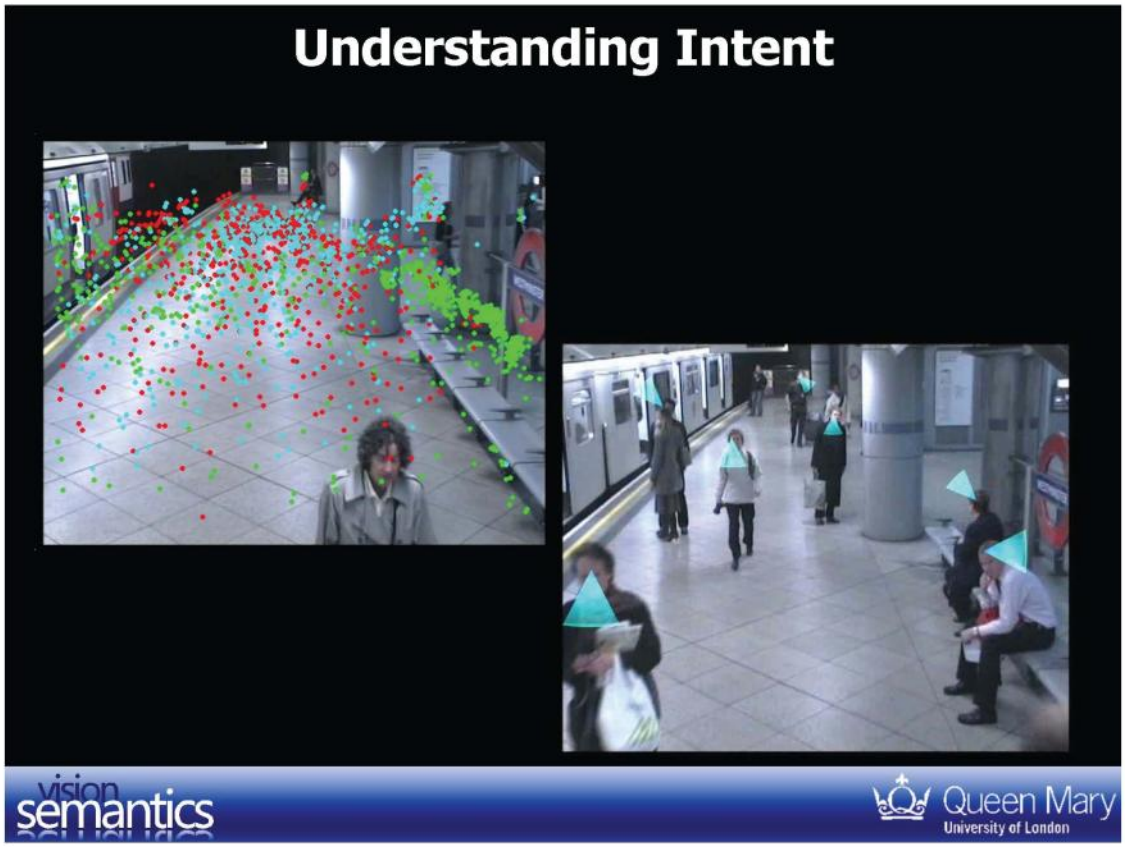
vision semantics

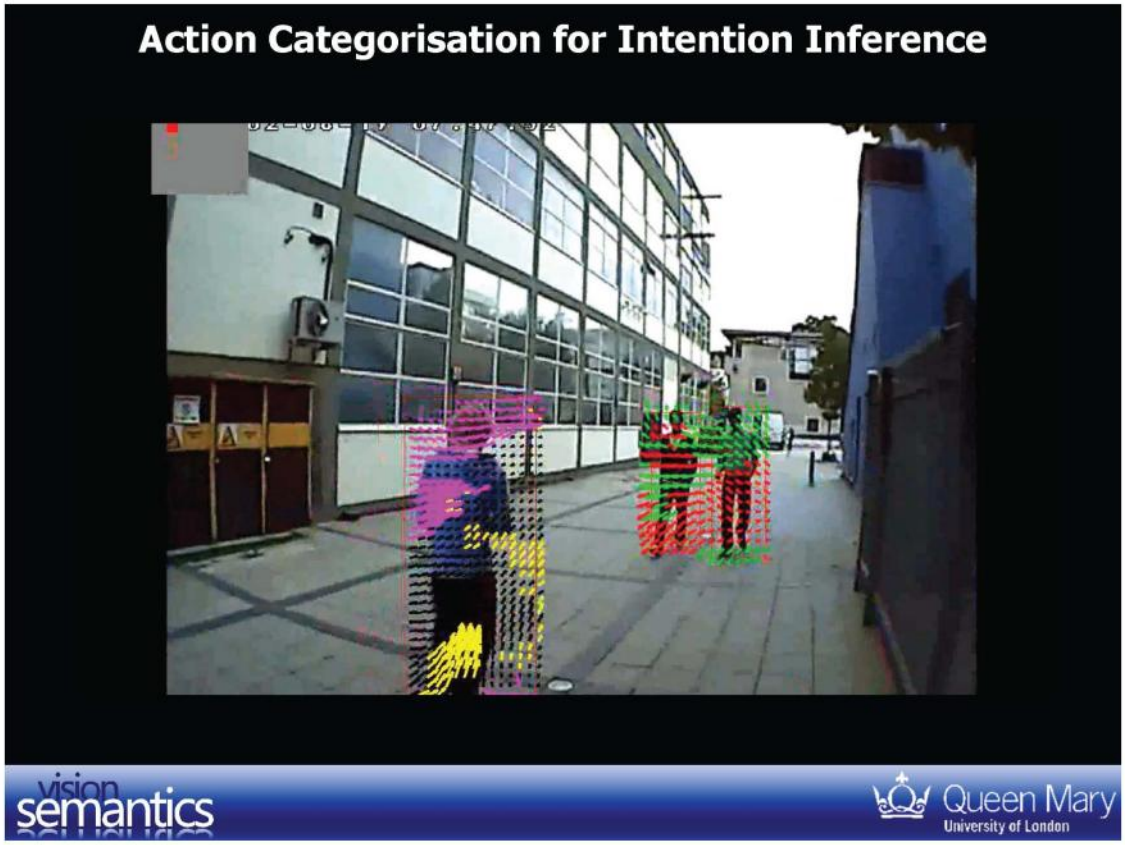
Queen Mary University of London


Anomaly Detection
Visual Event Likelihood
Unusual
vision semantics
Queen Mary University of London

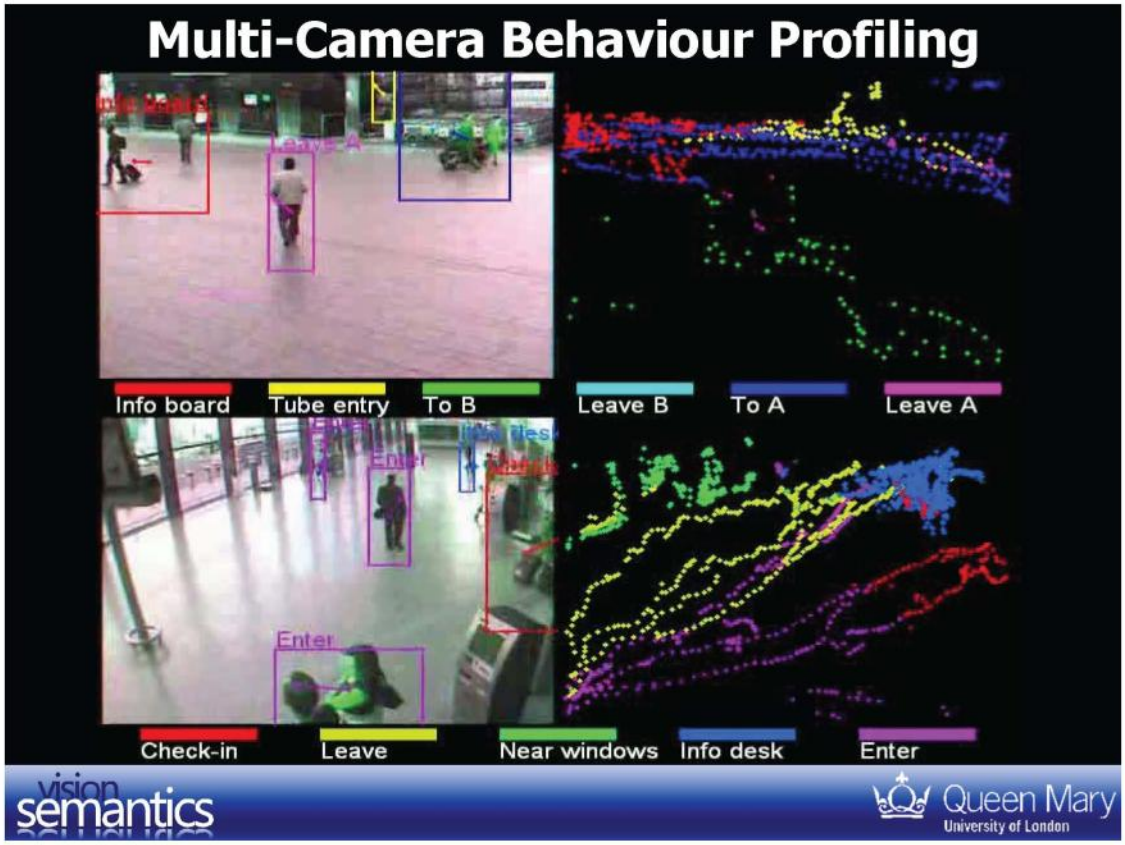

Man-in-the-Loop Active Learning
Request Human Feedback
FP
FP
TP
TP
TP
vision semantics
Queen Mary University of London


Intention Inference
Low Resolution
Illumination Uncertainty
Unpredictable appearance
Crowded spaces
vision semantics
Queen Mary University of London


Understanding Intent
vision semantics
Queen Mary University of London


Action Categorisation for Intention Inference
vision semantics
Queen Mary University of London


Finding People with Bags
4849
342
True Positives
False Positives
HOG (No Thresholding)
HOG (with 0.1 Recall-Rate in Precision-Recall-Curve)
102
109
374
104
TAS (with 0.1 Recall-Rate in Precision-Recall-Curve)
MMC (with 0.1 Recall-Rate in Precision-Recall-Curve)
107
70
vision semantics
Queen Mary University of London


Multi-Camera Behaviour Profiling
Info board
Tube entry
To B
Leave B
To A
Leave A
Check-in
Leave
Near windows
Info desk
Enter
vision semantics
Queen Mary University of London


Multi-Camera Re-identification
Probe Video
Matched Gallery Video
Probe Image
Top 6 Matched Image
vision semantics
Queen Mary University of London

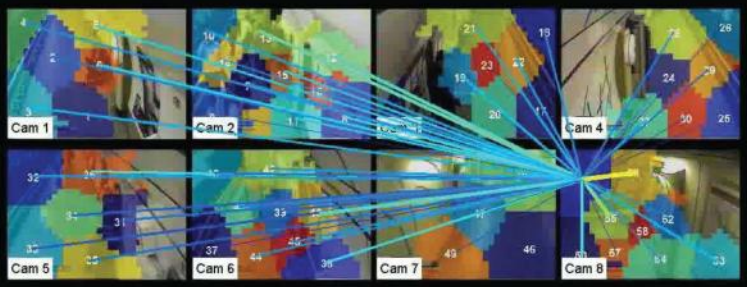
Global Situational Awareness: Connecting Dots

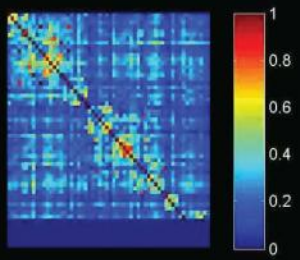
- Difficult to make sense of isolated activities from a single view & location
- Discovering global behavioural patterns from multiple sources of observation
- Connecting the dots: Detecting 'surprises' over disjoint physical loci

vision semantics

Queen Mary University of London

Machine Learning of Global Behavioural Correlation





Regional Activity Affinity Matrix

vision semantics

Queen Mary University of London

Multi-Camera Crowd Analysis

vision semantics

Queen Mary University of London

Take Home Message

1. More is not enough; Not all pixels (data) are equal
   - Selection is critical
   - Optimisation (filtering noise) is not enough
2. Pixel (data) alone is not enough
   - Utilising human knowledge interactively
3. Modelling context is essential
   - Bridging knowledge and data association
   - Making sense in context
4. Holistic (space, time & heterogeneous) correlation

vision semantics

Queen Mary University of London

Video Analytics The NICE Way

Guy Lorman,
NICE Systems, IL

NICE Intent. Insight. Impact.

Video Analytics The NICE Way

Guy Lorman | Product Management

www.nice.com

Agenda

NICE

- About NICE
- Security Management
  - 4G PIDS (perimeter intrusion detection solution)
- Passenger management
  - Overcrowding detection
  - Mass Passenger counting
- Research activities

2

NICE by Numbers

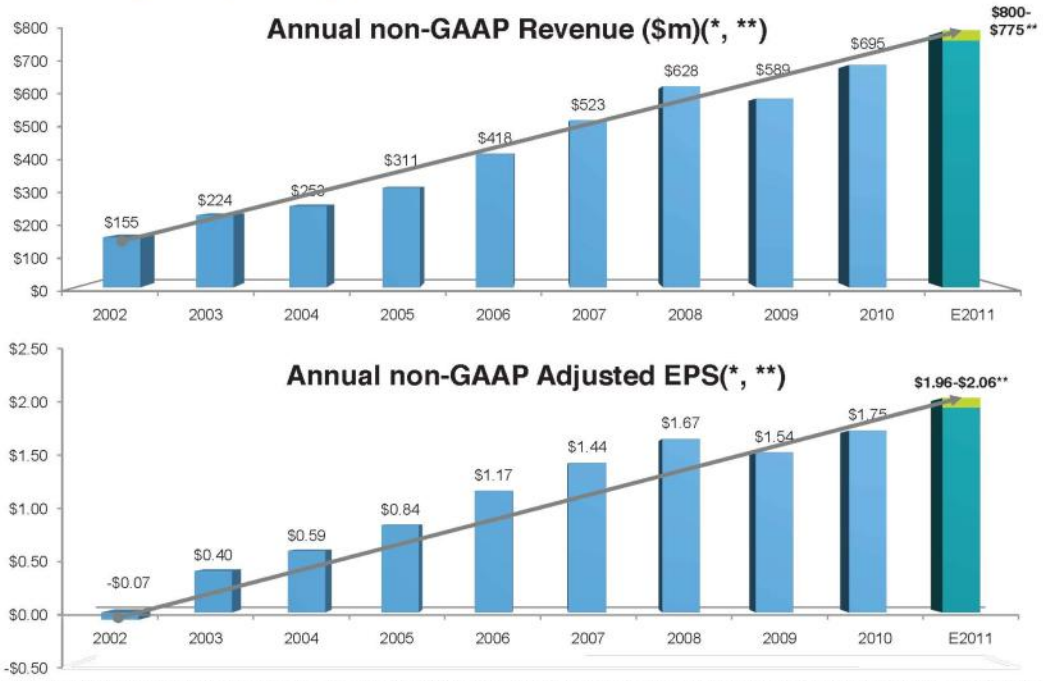
NICE

- 1986 — Founded (NASDAQ: NICE)
- 25,000 — Customers
- >80 — Fortune 100 Customers
- 150+ — Countries with NICE Presence
- 30 — Local Offices
- 5 — R&D Centers
- ~2800 — Employees
- >800 — Service Professionals
- >150 — Registered Patents WW (+88 pending, as of 08/10)
- $695M — 2010 Revenues

3

Impressive Growth Trajectory

NICE



Excludes adjustment of acquired deferred revenue, amortization of acquired intangible assets, expensing of options and one time items, and settlement and related expenses adjusted to refle split effective May 31, 2006

*** Per Company guidance on February 15, 2011*

NICE Offerings

5

Participation in Leading Industry Consortium – SECUR-ED

- Consortium for FP7's 3rd security call: Security of mass transportation
- ~€25M funding by EC
- The consortium focus on developing and demonstrating :
  - Physical protection and infrastructure resilience; video analysis; information management, training , and interoperability
  - Demonstrations : Berlin, Paris, Madrid and Milan
- Consortium consists of leading industry bodies, trade organizations, research institutes and operators

Industry	Operators	Research institutes	Trade organizations
THALES	DB	Fraunhofer	UITP
BOMBARDIER	SNCF	TNO	unife
NICE	FNM	VTT	EURACOM
Sagem Sécurité		JRC	
ALSTOM		UNIVERSITÄT PADERBORN	
AnsaldoSTS		FOI	
		TECHNISCHE UNIVERSITÄT DRESDEN	

6

VIDEO ANALYTICS PORTFOLIO

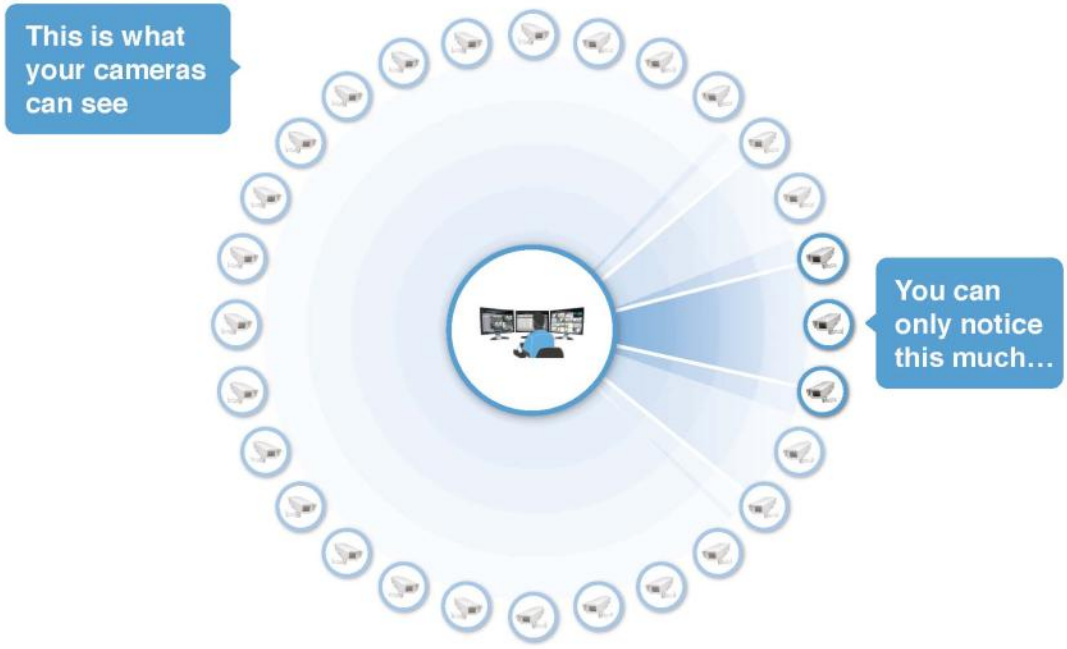
Portfolio

www.nice.com

8

The Missed Insights Paradox

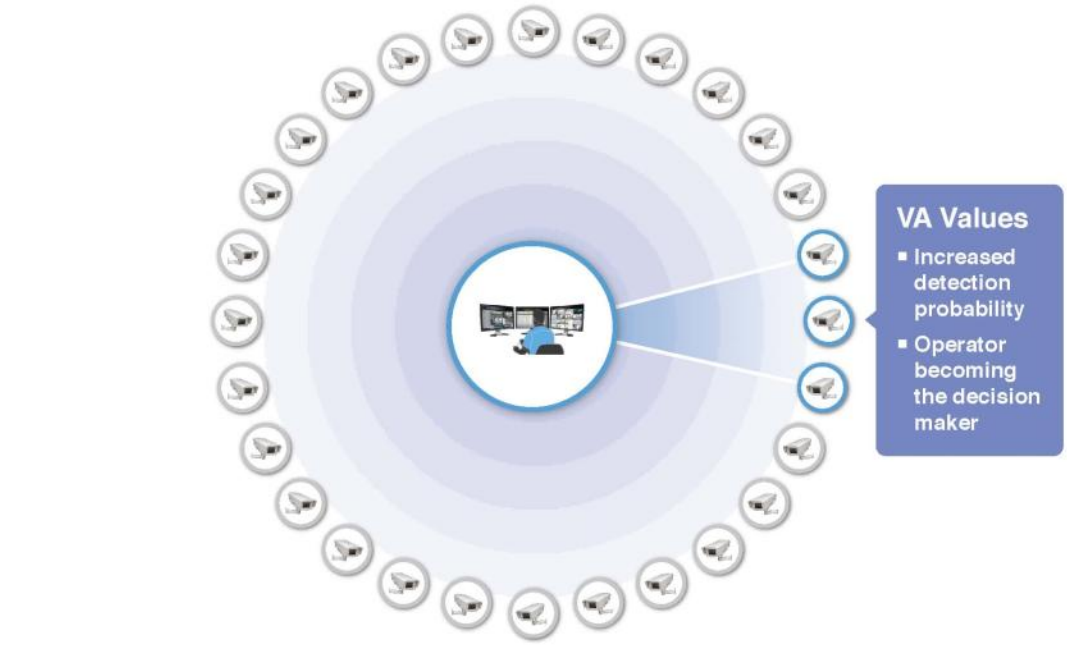
NICE



9

The Missed Insights Paradox

NICE



10

NiceVision Video Analytics Offering

NICE

Operational Insights

Video Analytics

Security Management

- PIDS
  - Intrusion Detection
  - Auto PTZ Tracker

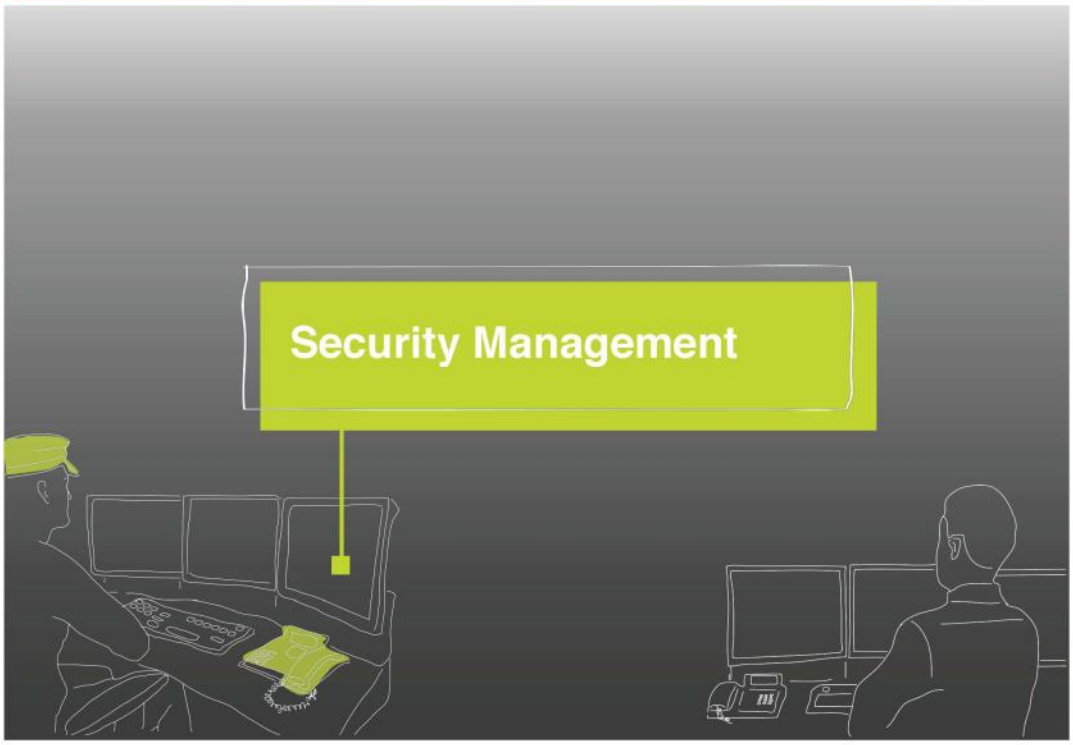
Vertical markets - Rail Transport, Airports, Critical Utilities

Passengers Management

- Crowd Control
- Counter Flow Detection
- People Counting
- Line Control

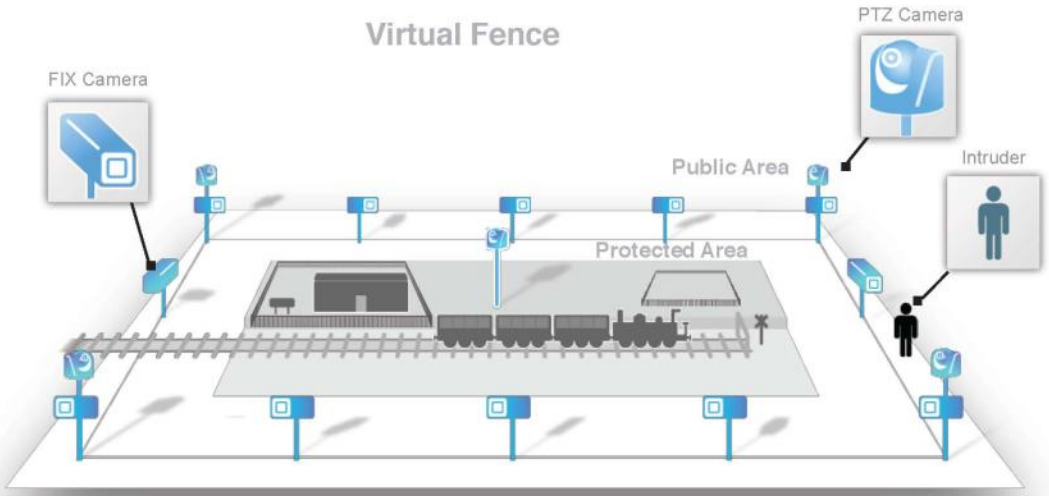
Vertical markets – Rail Transport and Airports

NICE



PIDS – Perimeter Intrusion Detection Solution

NICE



Automatic PTZ Tracking (3)

NICE

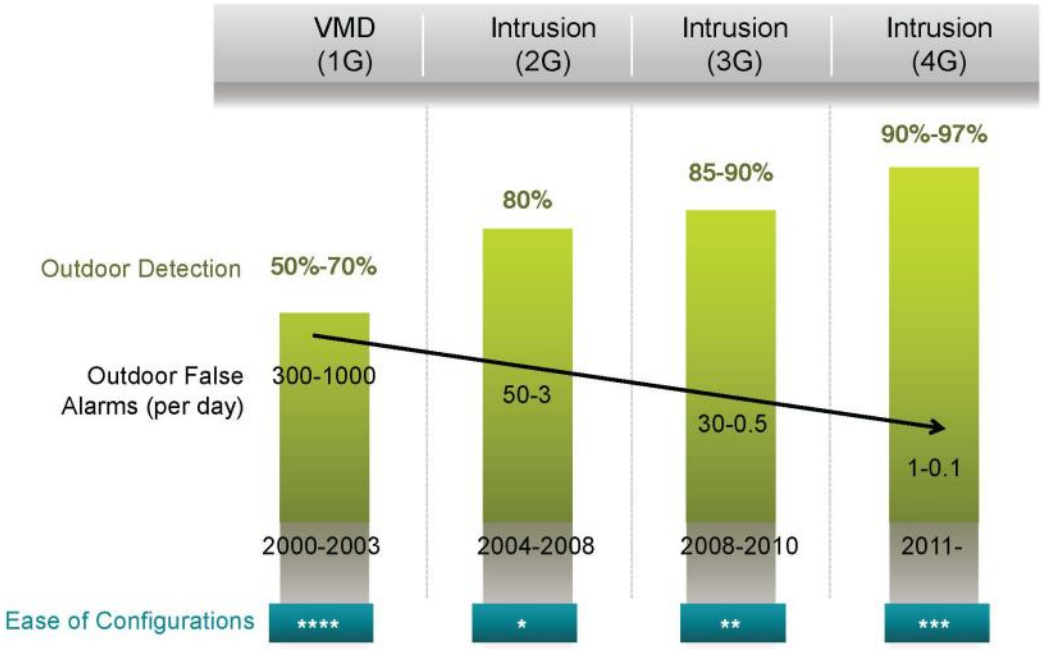
Fixed camera - Intrusion Detection

PTZ camera - Automatic PTZ Tracking

Objet location hand over

Intrusion Detection Evolution

NICE



Recent PIDS Achievements

NICE

Successful PIDS Solution

Israel critical facility

- 0.14 FA per cam per day
- >95% Detection Rate
- Sterile zone
- High quality design

Germany critical facility

- 0.5 FA per cam per day
- >94% Detection Rate
- Very challenging environment
- Sub optimal design
- Vegetation
- Vehicle lights in the area of interest

Israeli Railway

- Out performed competitors
- Better detection rate
- Lower false alarm rate

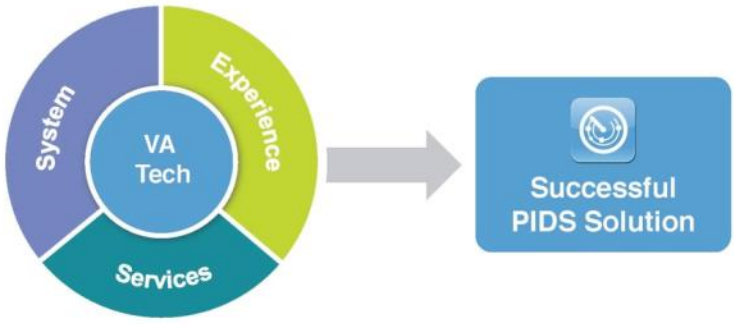
India Metro

- 3000!+ VA channels

Note – Site statistics are averaged, per camera, over a period of several weeks

Successful PIDS Solution

NICE



- State of the art, In house, Video Analytics Technology **- VA Tech.**
- Integrated Surveillance **System**
- 10 years of **Experience** with Video Analytics
- Video Analytics professional **Services**

17

Intrusion Detection CORE Enhancements in Net 2.5

NICE

- Advanced 24/7 all weather condition robustness
  - Improved adaptability for day night and different weather conditions with minimal setting effort
  - Tested on thousands of clips and in multiple environments
- State of the art - human object classification
  - Evaluates hundred of mathematical attributes to distinguish between humans and clutter
    - Shape
    - Contours
    - proportions
    - Texture

32

Weather Condition Robustness (1)

NICE

Detection of even small animals going in or out the critical facility, in harsh weather conditions

34

Night Condition Robustness (2)

NICE

- Detection of small objects during the night, with IR illumination
- IR Illumination is very well planned, and guarantee optimal performance
- Detection Rate > 95%; False Alarm Rate < 1 FA per Cam per week

37

State of the Art Filtering – Human Vs Clutter Classifier (1)

NICE

With Classifier

Filter out fence vibration and accurate human detection using classifier

48

China High speed Railway - Detection In Strong Winds

NICE

Without shaking filter

With shaking filter

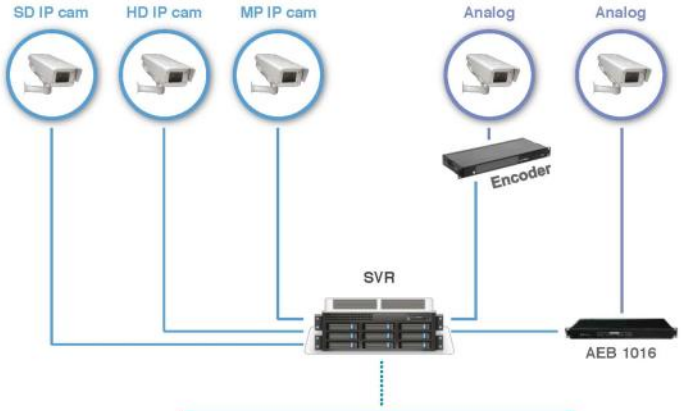
Operational system with over 800 PIDS cameras going over the Himalayas
More than 2000 PIDS cameras overall in the China high speed railway

16

Benefits of the VA Technology with NICE SVR

NICE

- Supporting any edge device SD, IP MP, HD or PTZ cameras
- Reduced TCO High Density Recording & Analytics Platform
- Flexibility to select any channel to support multiple VA
- Easy activation of multiple advanced video applications



New in Net 2.5

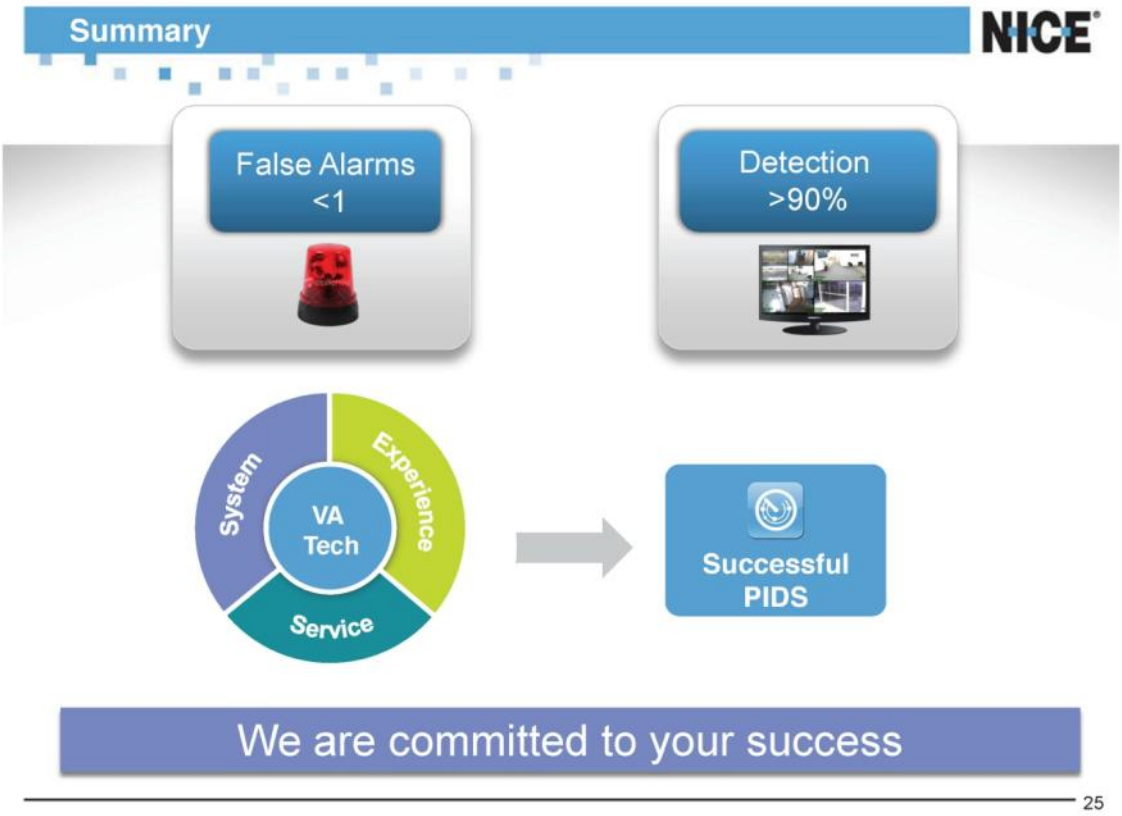
64

VA Professional Services

NICE

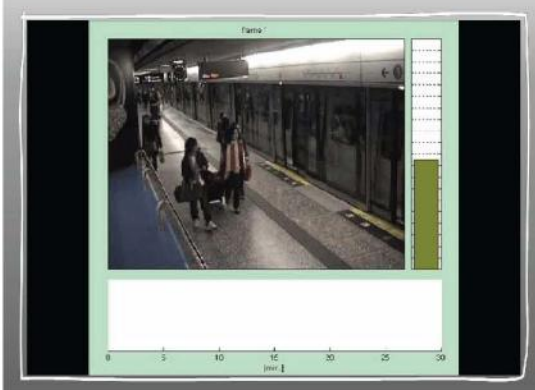
- Dedicated VA expert in every region
  - Consulting
  - Design
  - Site survey
  - Installation
  - Training
  - Maintenance & Support
- Set of processes and supporting documents
- In-house R&D support

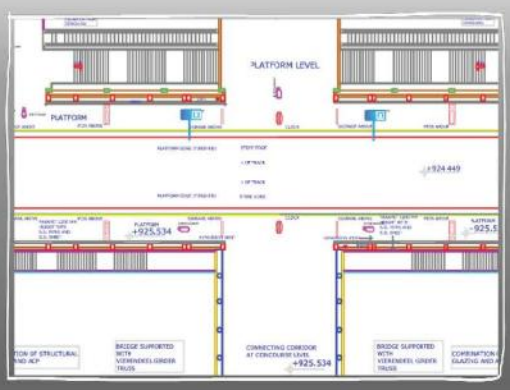
23


Summary
NICE
False Alarms
<1
Detection
>90%
System
Experience
VA
Tech
Service
Successful
PIDS
We are committed to your success
25


NICE
Passengers Management

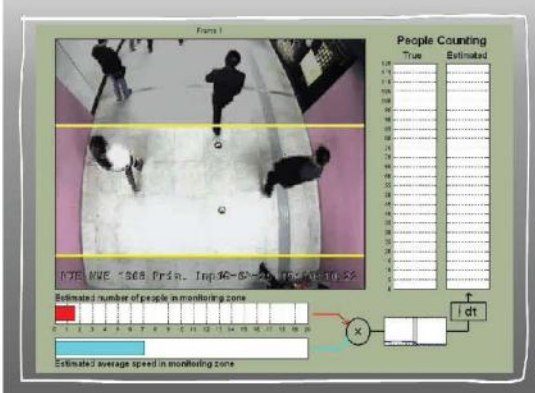
Passenger Load Monitoring - Technology

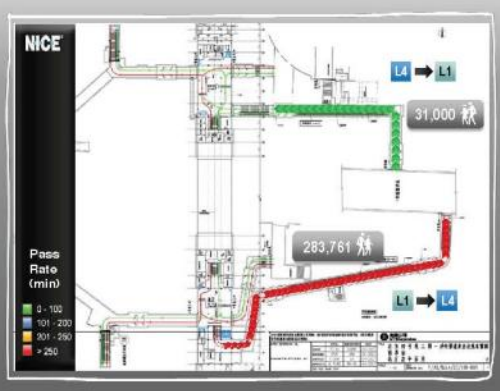




- Real time crowd estimation using Video Analysis (VA)
- Defined flexible criteria for abnormal overcrowding according to
  - Duration
  - Time of day
  - Comparison to the past

Mass Passenger Counting - Technology





- Mass passenger count
  - Real time counting
  - Very high load (up to 300 passenger per min)
  - High accuracy
  - Statistics and reports generation

VIDEO ANALYTICS RESEARCH ACTIVITIES

www.nice.com

Advanced Objects Classifier

Intrusion Detection – Scene Model Learning

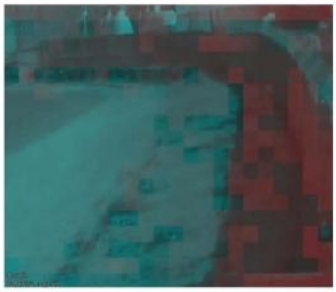
NICE

Changing scene conditions in typical intrusion detection site

31

Intrusion Detection – Adaptive Sensitivity

NICE



32

Intrusion Detection – Adaptive Sensitivity

NICE

Fixed Sensitivity

Adaptive sensitivity

33

Multi Cameras Calcification

NICE

- Using 2 cameras for improved classification
  - Range
  - Contour
  - Contrast

34

Multi Cameras Tracking

NICE

- Tracking designated object between different cameras, in challenging environment

35

Summary

NICE

Security Management
- **PIDS**
  - **Intrusion Detection**
  - **Auto PTZ Tracker**

Vertical markets - Rail Transport, Airports, Critical Utilities

Passengers Management
- **Crowd Control**
- **Counter Flow Detection**
- **People Counting**
- **Line Control**

Vertical markets – Rail Transport and Airports

36

Learn More

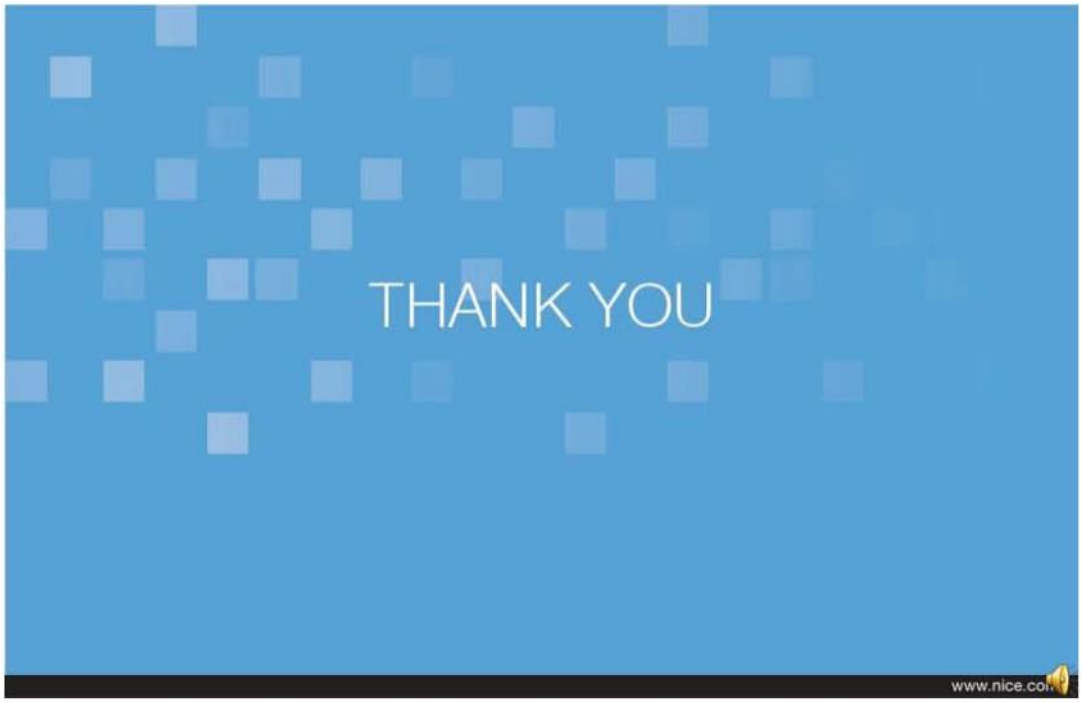
NICE

Clips available in publically

- PIDS Marketing Clip in YouTube
- Live PIDS Analysis flash clip

- Contact guylo@nice.com for more details

NICE Intent. Insight. Impact.



Current initiatives to drive performance and innovation in video detection systems

Stuart RANKIN, Kingsley SAGE
Home Office CAST, UK

CPNI
Centre for the Protection of National Infrastructure

Home Office
Centre for Applied Science and Technology

Current initiatives to drive performance and innovation in video detection systems

JRC - ISPRA
5th July 2011

Stuart Rankin and Dr Kingsley Sage

Home Office - CAST

- HOSDB recently changed it's name to CAST
  - Centre for Applied Science and Technology
- 200 Scientists and Engineers across 2 sites in the UK
  - Langhurst, West Sussex
  - Sandridge, St Albans
- Covering 7 'Capability Areas'
  - Physical Security
  - Crime Investigation
  - Crime Prevention
  - Biometrics
  - Surveillance
  - Contraband Detection
  - Horizon Scanning

Vision Based Security

- **i-LIDS – Imagery Library for Detection Systems**
  - Development of datasets
  - Provision of evaluations
  - Challenge events to drive development and innovation
- **Operator Performance Benchmarking**
  - Development of guidance documentation
  - Delivery of experimental trials
  - Best practice investigation
- **European Programmes**
  - ADABTS Abnormal behaviour detection
- **Advice and Support**
  - Working with various government end users to provide advice and support for video analytics and associated technology

Centre for Applied Science and Technology

Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Imagery Library for Intelligent Detection Systems

- Promote innovation in assistive CCTV technology
- Utilise & improve current CCTV infrastructure
- To set standards with video based detection systems
- Ensure best practice and value for money
- Based on the production of high quality video datasets

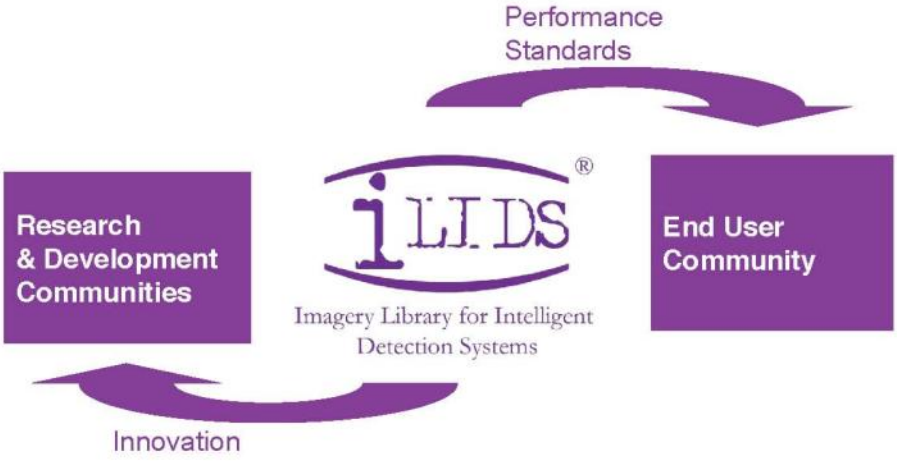
Centre for Applied Science and Technology

Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

The i-LIDS Project



Centre for Applied Science and Technology

Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Event Detection Scenarios

- Doorway Surveillance
  - 2 Stages
- Parked Vehicle
  - 3 Stages
- Abandoned Baggage
  - 2 Stages
- Sterile Zone
  - 2 Stages
- Real world threats
- Varied conditions

Centre for Applied Science and Technology

Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Event Detection - New Technologies

- 3 Imaging modalities across 3 different scenes
- Views across sterile land (500m), open water and along a Jetty

LW Thermal
8-12µm un-cooled
250*320 resolution
14° Field of View

MW Thermal
3-5µm cooled
512*640 resolution
17° Field of View

B/W Visual
NIR Illumination
PAL resolution
31° Field of View

Centre for Applied Science and Technology
Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Event Detection - New Technologies

- 3 Imaging modalities across 3 different scenes
- Views across sterile land, open water and along a Jetty

LW Thermal
8-12µm un-cooled
250*320 resolution
14° Field of View

MW Thermal
3-5µm cooled
512*640 resolution
17° Field of View

B/W Visual
NIR Illumination
PAL resolution
31° Field of View

Centre for Applied Science and Technology
Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Event Detection - New Technologies

- 3 Imaging modalities across 3 different scenes
- Views across sterile land, open water and along a Jetty

LW Thermal
8-12µm un-cooled
250*320 resolution
14° Field of View

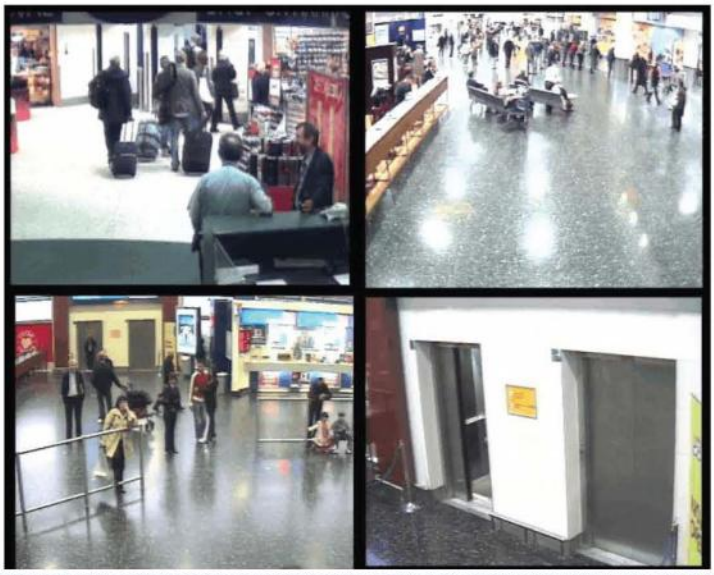
MW Thermal
3-5µm cooled
512*640 resolution
17° Field of View

B/W Visual
NIR Illumination
PAL resolution
31° Field of View

Centre for Applied Science and Technology
Stuart Rankin
CPNI Centre for the Protection of National Infrastructure
Home Office

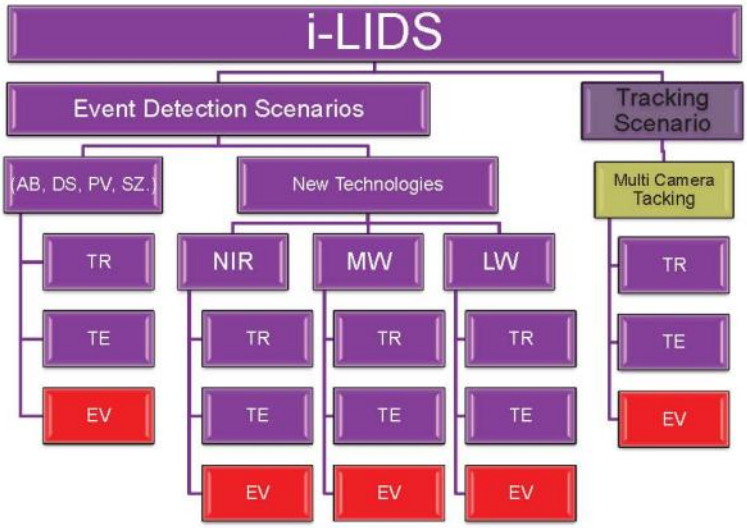
Multiple Camera Tracking

- 5 Camera Views
  - 1 Non overlapping
  - 4 Overlapping
- Busy transport hub
- Challenging
  - Occlusions
  - Busy scenes
  - Analogue CCTV



Centre for Applied Science and Technology
Stuart Rankin
CPNI Centre for the Protection of National Infrastructure
Home Office

Dataset Structure



- Event Detection
  - 24 Hours
- New Tech
  - 48 Hours
- MCT
  - 20 Hours

Centre for Applied Science and Technology

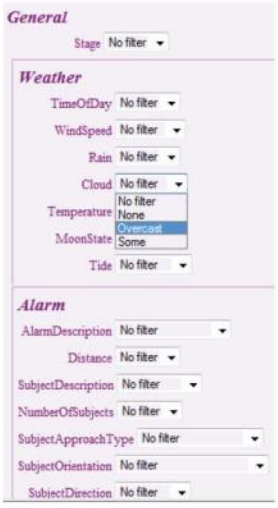
Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Dataset Distribution

- Training Dataset
  - Short clips contain individual threats
  - Systems can be 'trained' on each clip
  - External HDD with HTML front end
- Test Dataset
  - Clips simulate CCTV camera feeds (≥ 40 Mins)
  - Contains a variety of threats in each clip
  - Designed to 'test' systems for operational use
  - External HDD with HTML front end



Centre for Applied Science and Technology

Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Evaluations

- Identify high performing systems
  - 3 Classifications in Operational Alert
    - Weighted towards low false alarm rate
      - Primary
      - Secondary
      - Approaching
  - Event Recording role
    - Weighted towards detection
    - System is classified as Event Recording

Centre for Applied Science and Technology
Stuart Rankin
CPNI Centre for the Protection of National Infrastructure
Home Office

Challenge Events

- To invite academics to test against i-LIDS scenarios
- AVSS Challenge
  - http://tinyurl.com/cast-avss
    - Multi-Camera Single Person Tracking (MCSPT)
    - Single Camera, Single Person Tracking (SCSPT)
    - Camera Pair Single Person Tracking (CPSPT)
- Trecvid
  - http://tinyurl.com/cast-trecvid
    - Detection of specific activities

Centre for Applied Science and Technology
Stuart Rankin
CPNI Centre for the Protection of National Infrastructure
Home Office

Operator Performance Benchmarking

- Joint initiative between HO-OSCT (CONTEST), HO-CAST and CPNI
- Developed in response to Home Office **CONTEST** requirements
  - To understand the role and effectiveness of human operators in detection and tracking tasks.
  - To steer the effective development of automated detection and analysis systems to ensure that their capabilities most closely match the end user requirement.
  - To provide an understanding of the factors that limit the effective functioning of a CCTV control room
  - Enable guidance to be developed on how effectiveness/efficiency can be improved in the gathering and processing of surveillance data.

Centre for Applied Science and Technology
Stuart Rankin
CPNI Centre for the Protection of National Infrastructure
Home Office

Aims and objectives

- Ultimately to produce advice and guidance documents that will enable end users to answer questions like:
  - What factors impact the most on the performance of human operators in detection and tracking tasks?
  - How do human operators compare to video analytics systems for particular tasks?
  - How can I produce a cost benefit analysis and estimate the added value of introducing video analytics for my site?
- To produce this advice based on the latest research and through experimental trials
- To reduce reliance on "received wisdom", "urban myth" and out of date or irrelevant sources of information

Centre for Applied Science and Technology
Stuart Rankin
CPNI Centre for the Protection of National Infrastructure
Home Office

Project Structure

Centre for Applied Science and Technology
Stuart Rankin
CPNI Centre for the Protection of National Infrastructure
Home Office

Phase 1 - "State of the art" review

- To understand the role and effectiveness of human operators in detection and tracking tasks
- To provide a understanding of the factors limiting effective CCTV control room operation
- Enable guidance to be developed on how effectiveness/efficiency can be improved in the gathering and processing of surveillance data
- Draw on existing research and best practice in application areas such as rail, maritime, aviation and perimeter security
- Identify where useful research exists and highlight areas where research is lacking and/or out of date or no longer relevant

Centre for Applied Science and Technology
Stuart Rankin
CPNI Centre for the Protection of National Infrastructure
Home Office

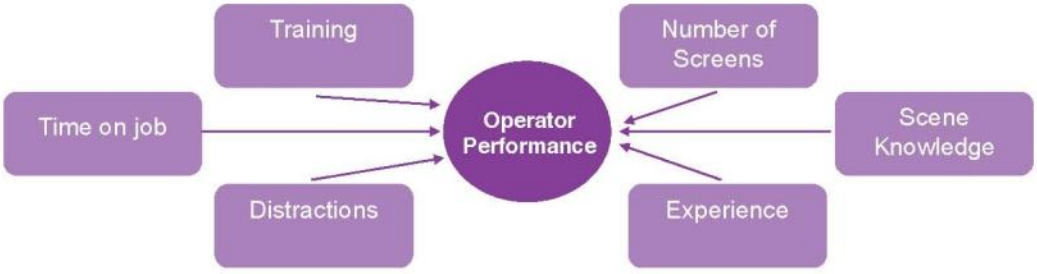
Phase 1 - "State of the art" review

Academic research	Commercial best practice
Relevant trial results	Best Practice
Psychology research	Ergonomics
Cognitive science	Systems integration
Behavioural studies	
Information management	
Human factors	
Scene complexity	
Control room design and complexity	
Task analysis and type	
Human perception studies	
Information Processing	
Task loading	
Data fusion	

Centre for Applied Science and Technology
Stuart Rankin
CPNI Centre for the Protection of National Infrastructure
Home Office

Phase 2a and 2b Experimental Trials

- 2 Small scale experiments informed by the state of the art review
- Establish experimental procedures for further experiments (phase 2b)
- Intended to explore basic issues of operator performance such as detection performance over time, and whether any obvious differences in attention between trained and untrained operators



Centre for Applied Science and Technology
Stuart Rankin
CPNI Centre for the Protection of National Infrastructure
Home Office

Data for trials

- Preliminary trials have used 2 i-LIDS event detection scenarios to test participants. Further trials will utilise a broader range of the datasets available

Centre for Applied Science and Technology

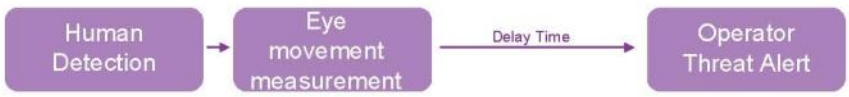
Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Initial experiments (Phase 2a)

- Academic research team
  - Looking at patterns of eye movements during a detection task
  - Working with untrained operators (12 for initial study)
  - Looking to see what patterns of eye movements are associated with "suspicious" event detection
  - Investigate if eye movement patterns are similar
  - Results will be compared with i-LIDS ground truth/ judgements from novices and experts, and a signal detection theory analysis applied. This will inform our understanding of CCTV operator training and performance.
  - Trials to investigate the help/hindrance of assistance technology (Correct/Incorrect)



Centre for Applied Science and Technology

Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Initial experiments (Phase 2a)

Commercial Research Team

The aim of this trial is to establish performance levels of CCTV operators in detecting events with and without assistance.

The participants will consist of 12 CCTV operators doing live searching. Data will be collected from each participant for each of the conditions outlined below.

	Operator only	Operator plus assistance
Doorway surveillance	√	√
Doorway surveillance	√ Plus additional task	√ Plus additional task
Parking detection	√	√
Parking detection	√ Plus additional task	√ Plus additional task

A 20 minute clip from the i-LIDS data will be presented for each condition, with a short break in between.

Trial set-up showing doorway surveillance with additional task

Centre for Applied Science and Technology

Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Experimental Model: Phase 2b

Experimental procedure derived from Phase 2a trials

- Briefing (15 Minutes)
- Screen X Ability level testing (30 Minutes)
- Operator viewing trial (2.5 Hours)
- Debrief (15 Minutes)

Participants evaluated by the following

- True Positives – Detected Event occurring at correct time
- False Positive – Detected Event but False Alarm
- False Negative – Failure to detect an event

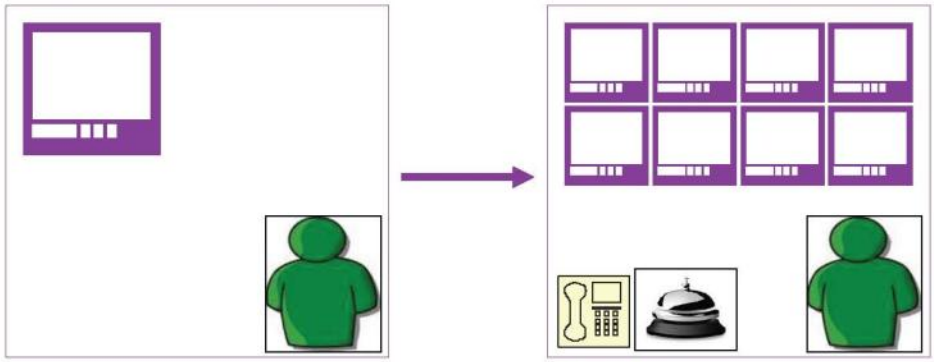
Centre for Applied Science and Technology

Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Experimental Model: Phase 2b



Task Complexity

1 Screen, Simple Task, No Distractions

Task Complexity

Many Screens (9 Max), Many tasks/targets, multiple distractions

Centre for Applied Science and Technology

Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Complexity Matrix

Task loading	Task Complexity: Simple	Involved	Complex
Low	Sterile Zone	Few targets Related events Medium frequency Busy scene Occasionally interrupted/obscured One monitor Baggage screening	Various targets Unrelated events High frequency Complex scene Discontinuous data One monitor Post event analysis
Medium	Single target Single event Low frequency Simple scene Contiguous data 1 - 9 monitors Additional tasks iLids Sterile Zone	Parked Vehicle	Various targets Unrelated events High frequency Some busy some complex scenes Discontinuous data 1 - 9 monitors Additional tasks Town centre CCTV
High	Single target Single event Low frequency Simple scene Contiguous data > 9 monitors Multiple tasks Audible and visual stimuli Security station	Few targets Related events Medium frequency Mostly busy scenes Occasionally interrupted/obscured > 9 monitors Multiple tasks Audible and visual stimuli Security station	Multiple Camera Tracking

To spread investigations across a range of variables, a complexity matrix has been developed and specific areas identified for further investigation

Tasks
Frequency
Distractions
Example

Centre for Applied Science and Technology

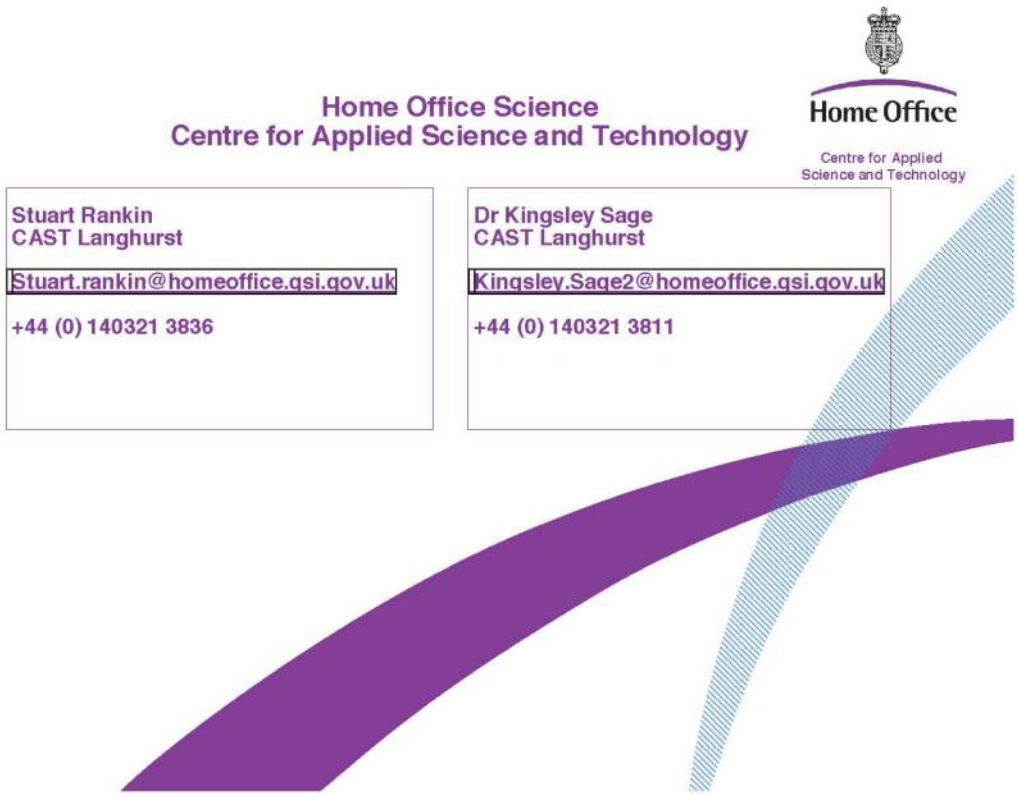
Stuart Rankin

CPNI Centre for the Protection of National Infrastructure

Home Office

Plans for 2011-12 – Phase 2b Trials

- To bring together learning from initial experimental trials and state of the art review
- Conduct informed set of wider experimental trials (Aug-Nov)
- Participation of trained and untrained human operators
- Compare performance of human operators against performance of video analytics systems using data derived from i-LIDS evaluations
- Use results to establish key performance issues
- Use data to produce new and revised guidance on the applicability and cost effectiveness of video analytics systems



Session 2: Capabilities (cont'd)

From detection & tracking to the analysis of social behaviour

Vittorio MURINO
IIT – UNIVR, IT

From detection and tracking to the analysis of social behavior

Vittorio Murino

istituto italiano di tecnologia

July 2011

Outline

- Short profile of the PLUS lab
- Prior work on video surveillance and related tasks
- The SAMURAI project
- Towards a Social Video Surveillance
- Some examples

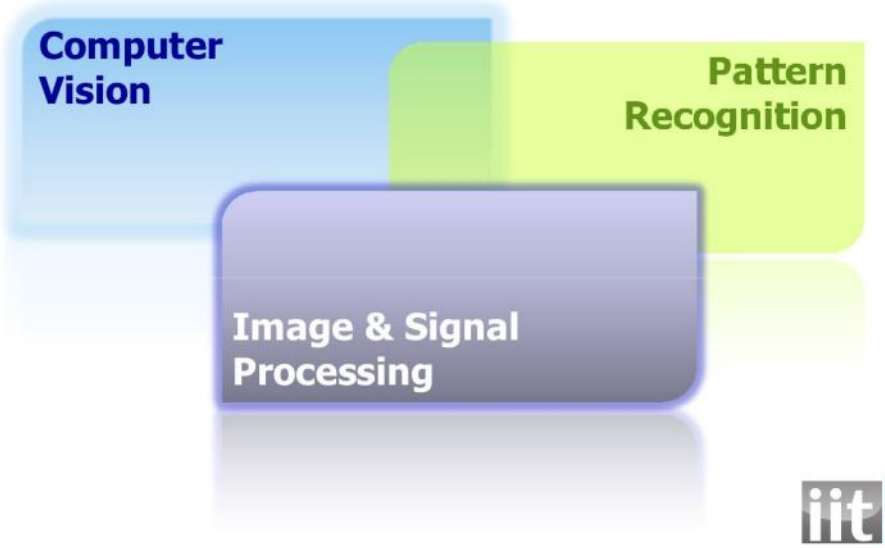
2

The PLUS crew

- **Vittorio Murino**
- Marco Cristani
- Alessio Del Bue
- Marco Crocco
- Minh Ha Quang
- Raghavendra M. Ramachandra
- Enver Sangineto
- Luca Giancardo
- Reza Sabzevari (*Ph.D. student*)
- Pietro Salvagnini (*Ph.D. student*)
- Simona Ullo (*Ph.D. Student*)
- Marco San Biagio (*Ph.D. Student*)
- Matteo Zanotto (*Ph.D. Student*)

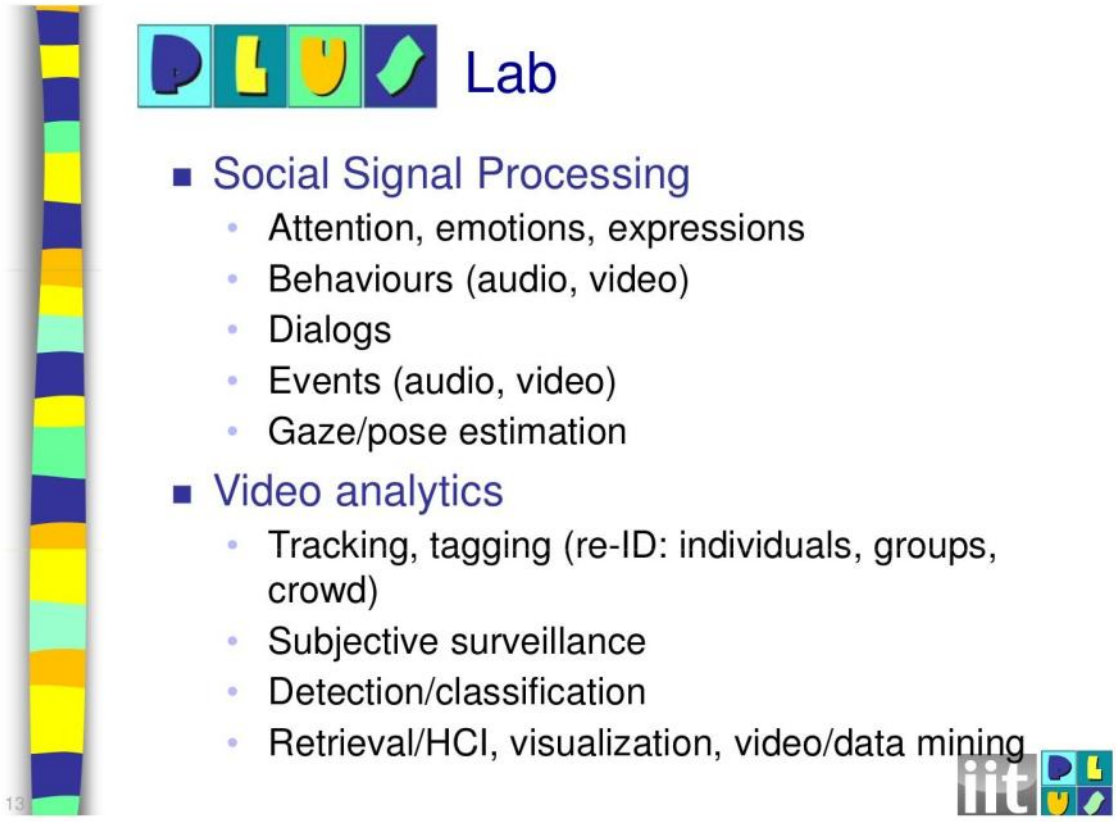
3

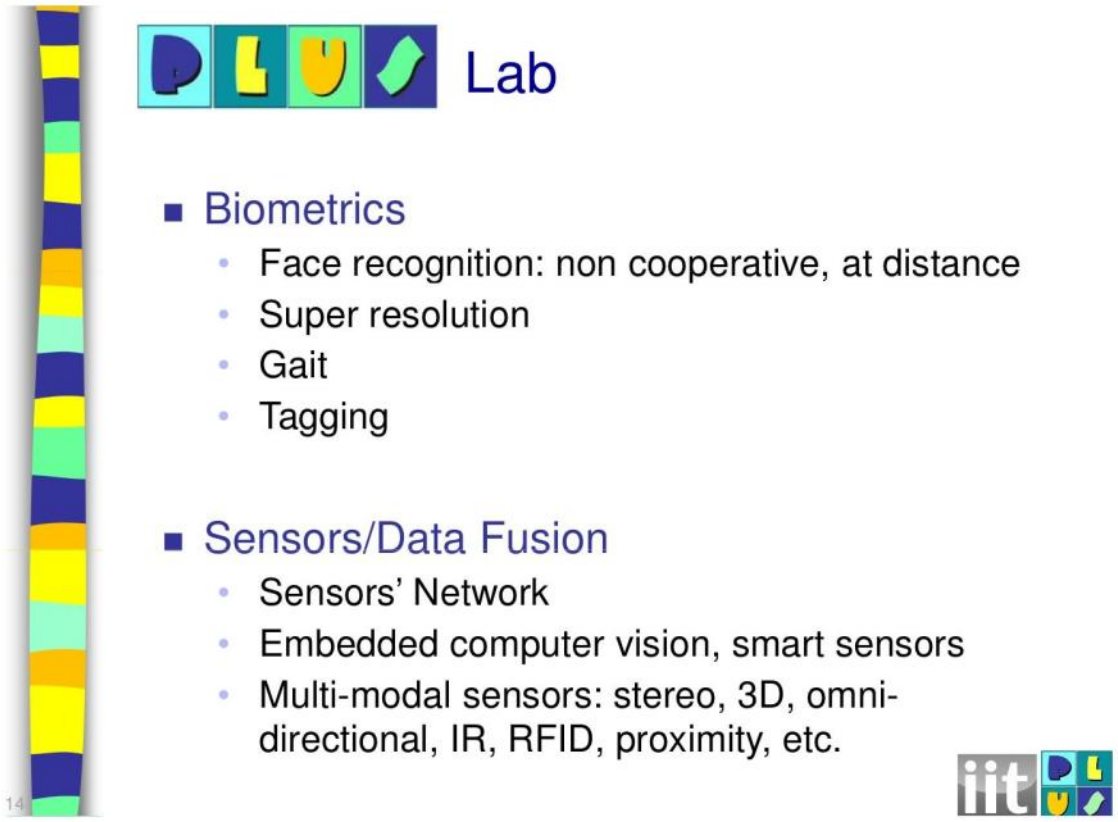
Expertise @ PLUS



4


Research @
PLUS lab @ IIT
Pattern analysis, Learning, and image Understanding Systems
Focus on (video) surveillance/security and biomedical image analysis, bioinformatics
Surveillance
Social Signal Processing
Video Analytics
Biometrics
Sensors/Data Fusion
12

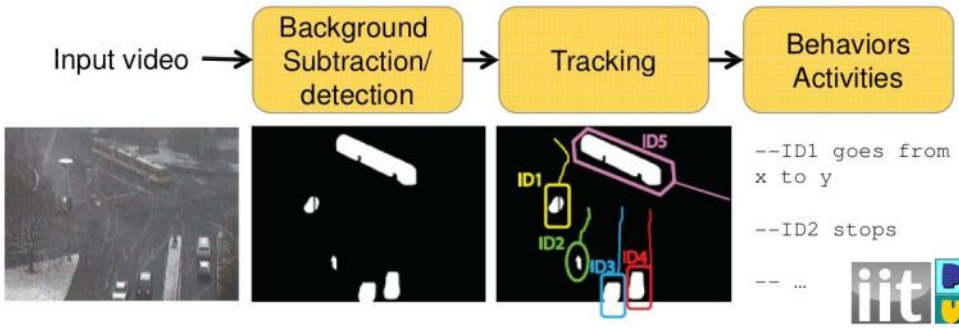

Lab
Social Signal Processing
Attention, emotions, expressions
Behaviours (audio, video)
Dialogs
Events (audio, video)
Gaze/pose estimation
Video analytics
Tracking, tagging (re-ID: individuals, groups, crowd)
Subjective surveillance
Detection/classification
Retrieval/HCI, visualization, video/data mining
13


Lab
Biometrics
Face recognition: non cooperative, at distance
Super resolution
Gait
Tagging
Sensors/Data Fusion
Sensors' Network
Embedded computer vision, smart sensors
Multi-modal sensors: stereo, 3D, omni-directional, IR, RFID, proximity, etc.
14


TYPICAL VIDEO SURVEILLANCE TOPICS
16

Video Surveillance

- Main aims
  - Address indoor-outdoor scenarios
  - Discover abnormal/threatening behaviors, activities, or events
- Usually, a serial framework is exploited



17

Video Surveillance

- The framework mainly focuses on a particular entity: the human being
- This aspect is usually not much exploited, actually
  - Individuals as mere objects acting independently wrt the context
  - No social aspects are properly addressed

18

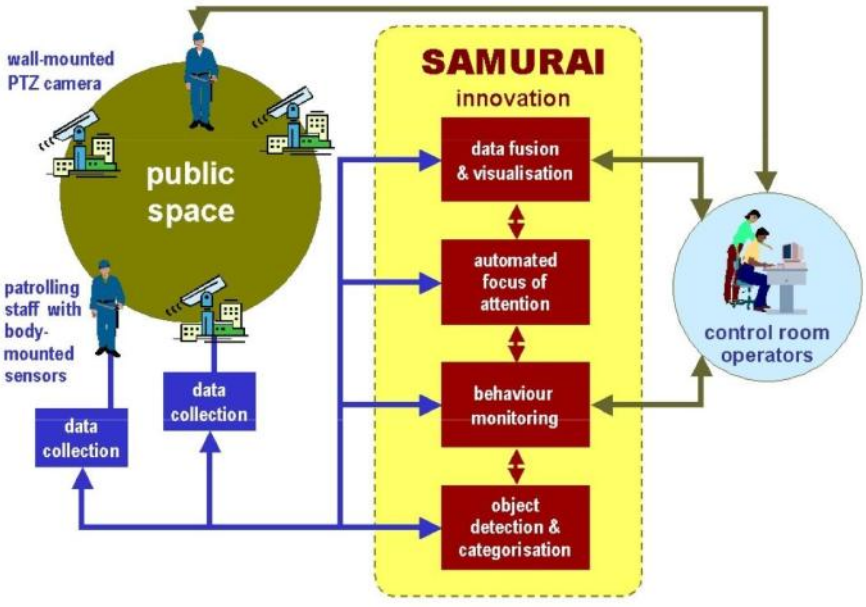
EU FP7 SAMURAI

Suspicious and Abnormal behaviour Monitoring Using a netwoRk of cAmeras for sItuation awareness enhancement

- European Commission Framework 7 Security Programme
- 2008-2011
- Consortium of 8 partners across 5 EU countries
- Led by Queen Mary University of London, prof. Sean GONG
- www.samurai-eu.org

19

Concept



21

Main tasks

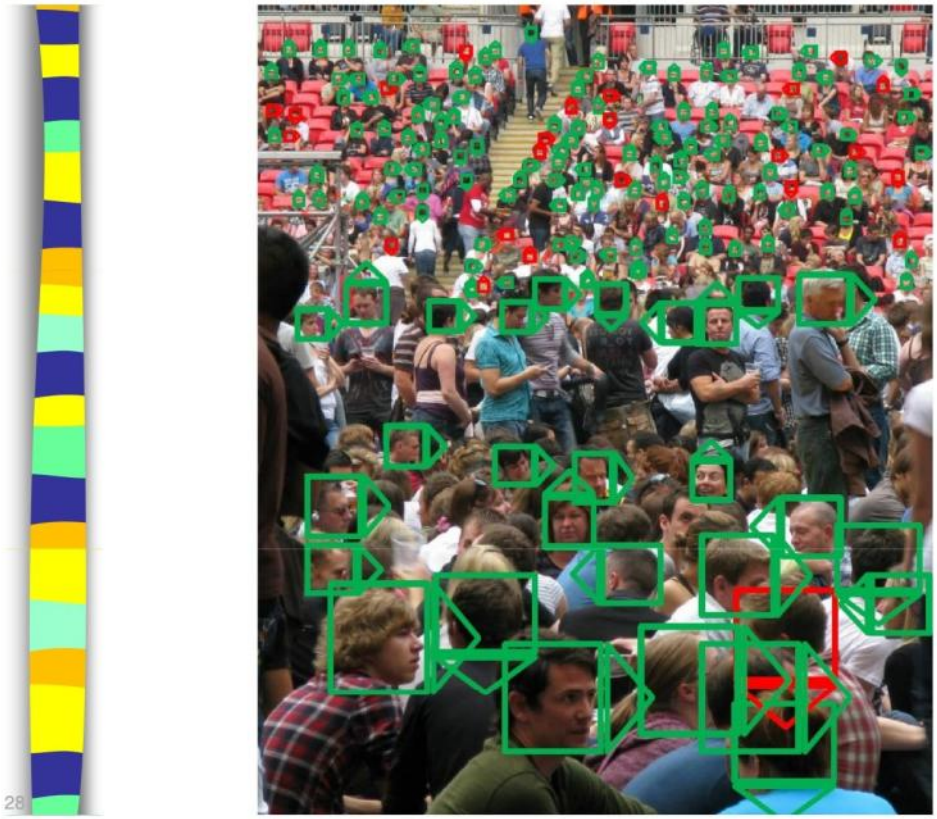
- Developing and integrating tools and techniques to perform the following tasks:
  - reliable background subtraction under real conditions
  - robust detection and categorization of people from a wide-area distance
  - robust detection and categorization of luggage and vehicles
  - Multi-camera object tagging or *re-identification*
  - Behavior monitoring for abnormality detection

23

People Detection

- Starting from the work of Tuzel et al. in PAMI 2008, we develop different detection frameworks, based on
  - Boosting
  - Learning on Riemannian Manifolds
- The most impressive result is a joint detector – multiclass classifier, employed for joint head detection and pose estimation (Tosato et al., ECCV 2010)

27



28

29

People Detection

Demo1 BAA Seq01 lobby – High resolution (video)

Dalal et al.

UniVR

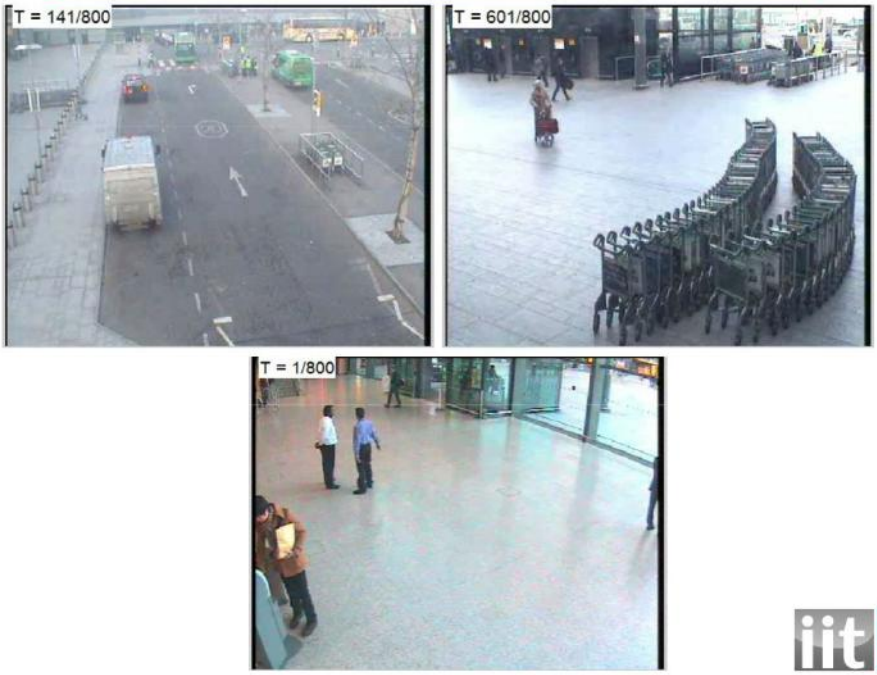
31

Tracking – *Results*

34

Tracking – *Results*

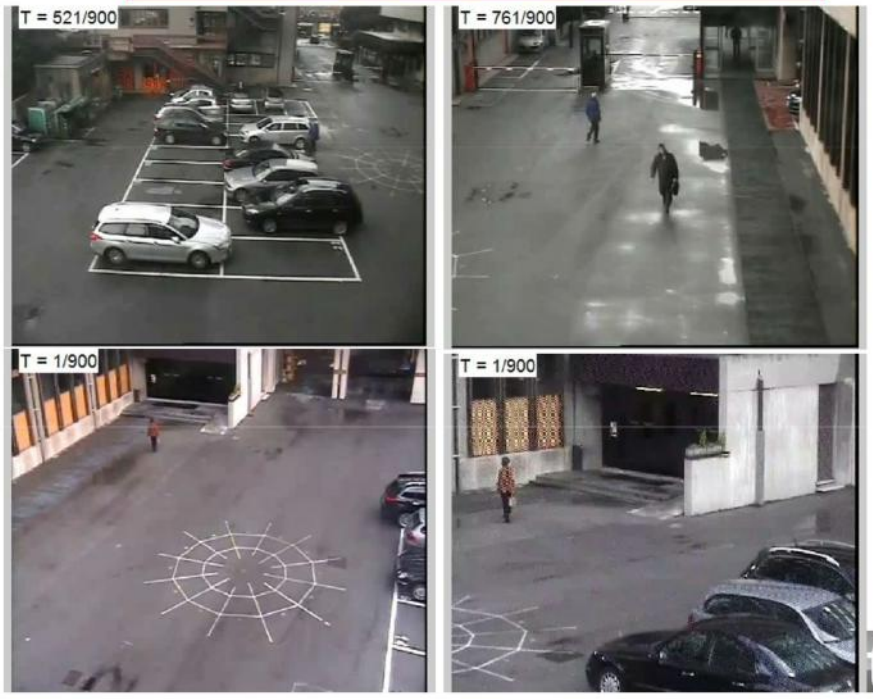
Demo1 BAA Seq02 lane1, forecourt, lobby (video)



35

Tracking – *Results*

Demo1 Elsag Seq01 (video)



37

Tracking – *Results*

Demo2 Elsag Seq02 (video)

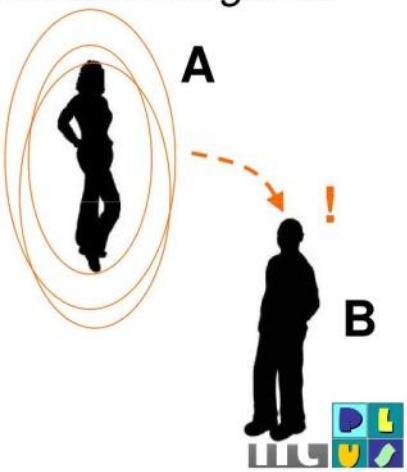
38

SOCIAL SIGNAL PROCESSING & VIDEO SURVEILLANCE

43

Social signal processing (SSP)

- A recent research field
- It aims at providing computers with the ability to sense and figure out human *social signals.*
- **Social signals** are cues:
  - non verbal
  - that carry social meaning



44

Social signal processing

- Social signals are organized in five *codes, where several behavioral cues are collected:*

1. *Physical Appearance*


Attractiveness


Clothes


Somatotype

2. *Vocal Behavior*

How words are pronounced

46

Social signal processing

3. *Face and Eyes Behavior*

4. *Gestures and Postures*

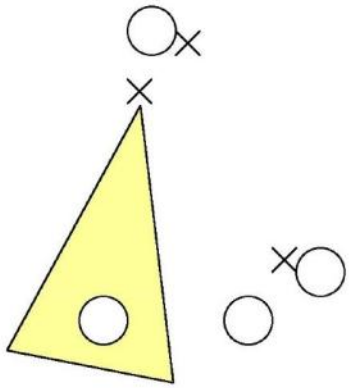
Conscious

Unconscious

47

Social signal processing

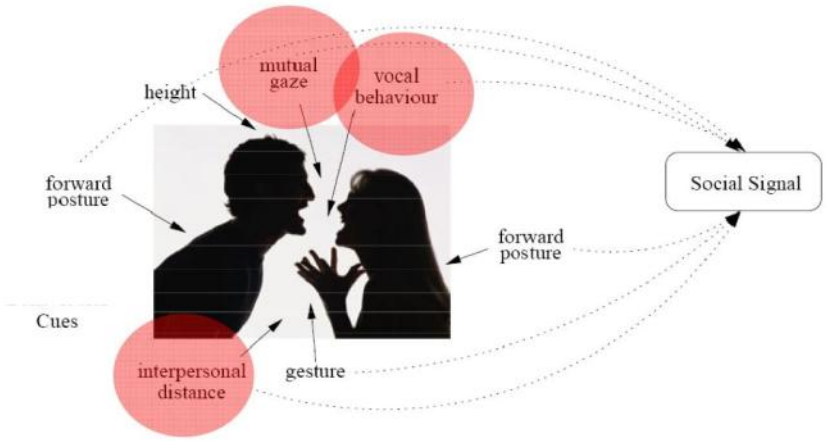
5. *Space and Environment*



Mutual distances,
spatial arrangement of people

48

Summarizing …



49

Social signal processing

- Scenarios taken into account by SSP approaches focus on face-to-face group interactions:
  - With few people involved
  - In a well constrained scenario

Sensor for high quality features

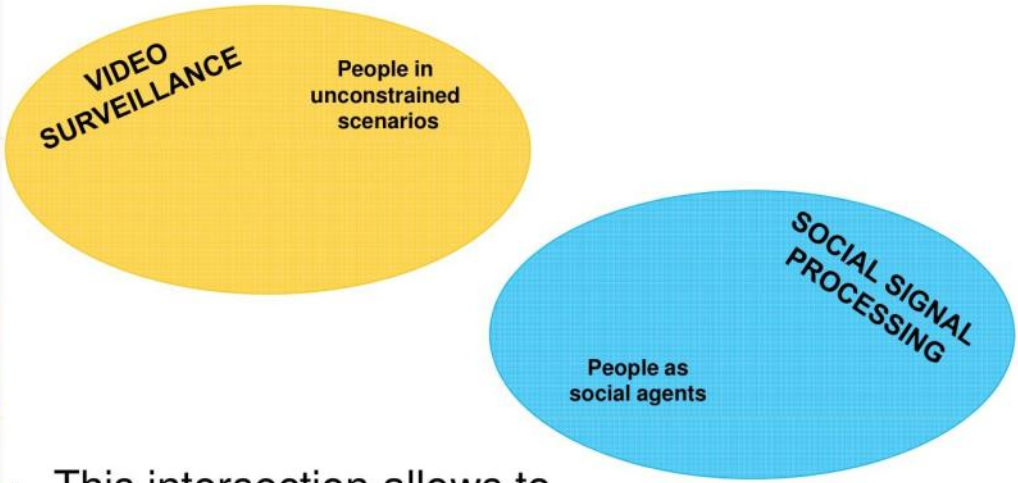
52

Social signal processing

- No uncontrolled, large scenario are taken into account, with people left free to move, act, and, possibly, interact
- A further issue: crowd behavior

53

Social signal processing



- This intersection allows to
  - Tackle issues of both disciplines
  - Put new research perspectives

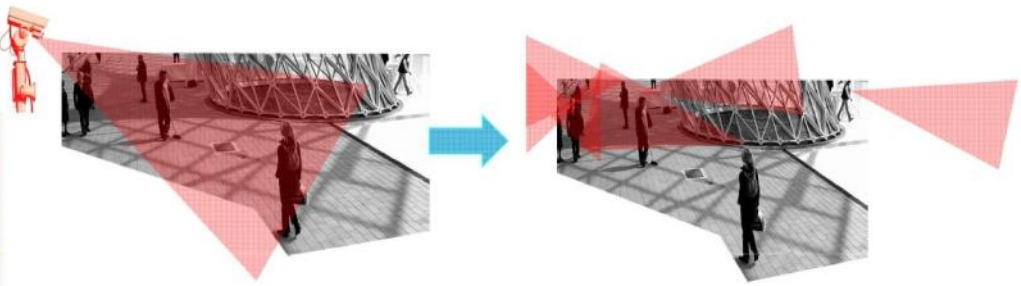
54

ESTIMATING THE FOCUS OF ATTENTION

55

Rationale

- Moving from a camera perspective to a *subjective* perspective

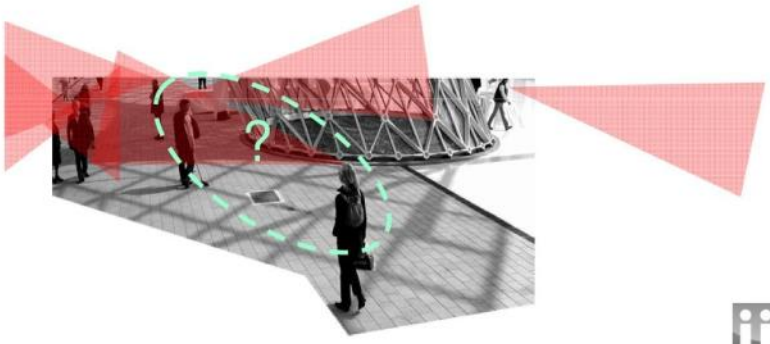


- In this way, it is possible to understand
  - How people interact with the environment
  - How people interact with each other

56

The objective

1. Estimate an important social cue, the Visual Focus Of Attention (VFOA), in a typical surveillance scenario
2. Exploit the VFOA to infer possible social exchanges occurring in a scene

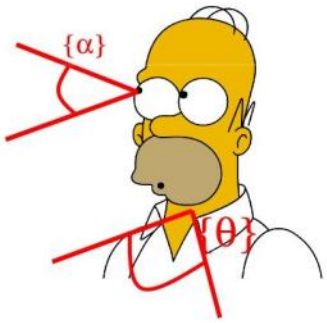


57

VFOA: definition

- The VFOA of a person is a very important social cue
- It indicates where a person is looking at
- It is mainly determined by

1. head pose, by the angles {θ}
2. eye gaze dynamics, by the angles {α}



58

VFOA: a more compelling scenario

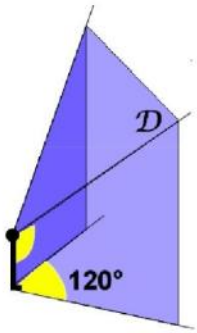
- The idea is to address a typical video surveillance scenario involving an indoor location, moderately crowded

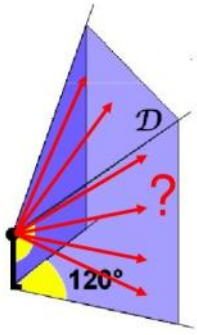
- In this situation we want to estimate, at each time instant, the VFOA of every person

59

VFOA: Subjective View Frustum

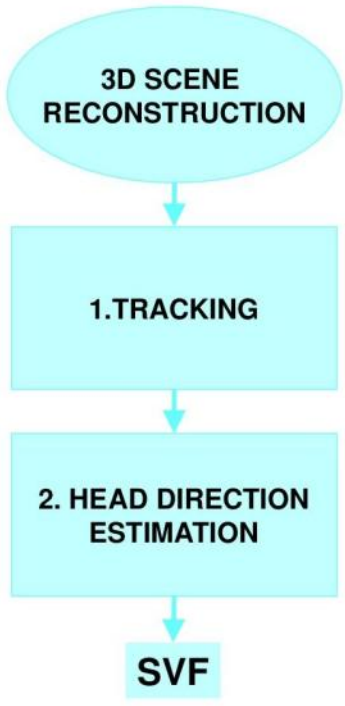
- The SVF is a polyhedron $\mathcal{D}$
- It is composed by three planes that delimit the angle of view on the left, right and top sides
- The angle view is ±120° in both directions
- The SVF contains the Visual Focus of Attention of a person, without indicating the precise direction
- Therefore, the SVF is an approximation of the VFOA





60

VFOA: how to estimate the SVF

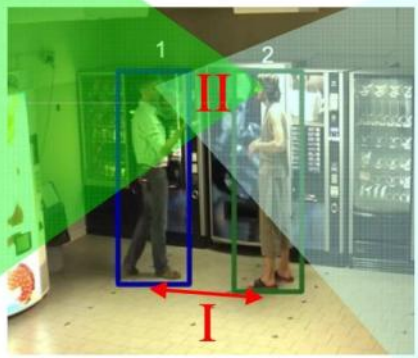


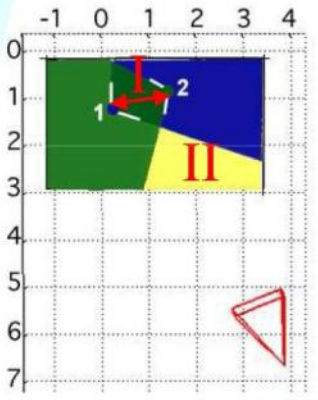
- The SVF is estimated using this simple processing pipeline
- It is composed by two modules:
  1. A tracking module
  2. A head direction estimation module
- The tracking holds in a pre-computed 3D map, obtained after a 3D scene reconstruction

61

Inter Relation Pattern Matrix

- Understanding social interactions: 2 conditions
  I. mutual proximity → from the tracking info
  II. visual lock → from the SVF

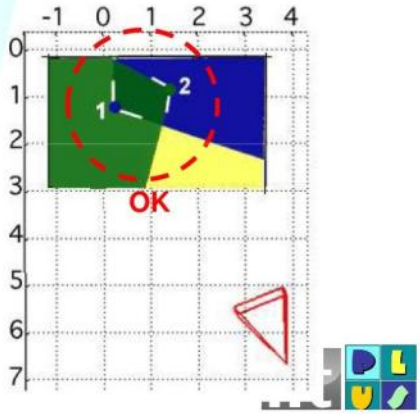




64

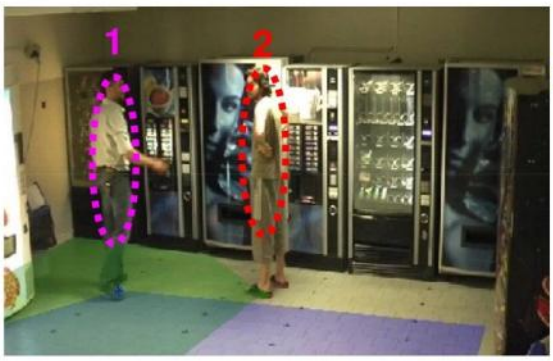
Inter Relation Pattern Matrix
Preliminaries

- In practice, for a 2-people interaction, we check that the head of the subject 1 falls in the SVF of subject 2 and viceversa
- The IRPM is *n* by *n* (*n* number of subjects) and the value contained in the cell (*i,j*) indicates how much subjects *i* and *j* are interacting

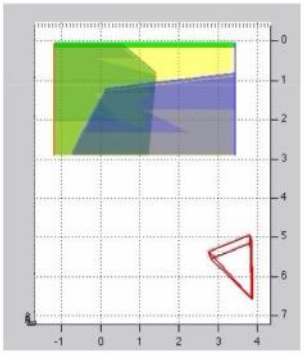


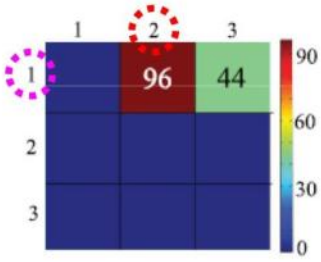
65

Experiments



- In the matrix we report the sum of those IRPM values ≥10 sec of continuos interaction





66

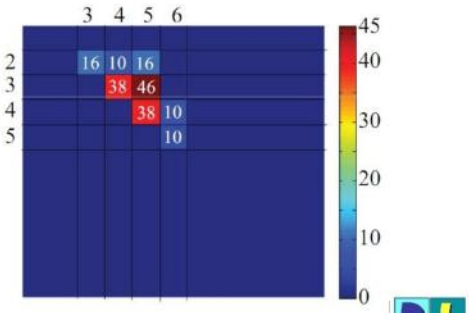
Experiments

- In total, we found 17/19 (89%) "long" social exchanges
- The errors were due to bad head orientation estimates, and tracking results

67

Experiments

2. Two sequences of the PETS 2007 database ($S07_{C2}$, $S07_{C4,}$ few minutes).
   - an airport area is monitored
   - no ground truth on social exchanges is available
   - only a quantitative analysis has been carried out



68

DETECTION OF SOCIAL INTERACTIONS

69

Detection of social interactions

Ongoing work:

- the idea is to define a group when people is static and interacting

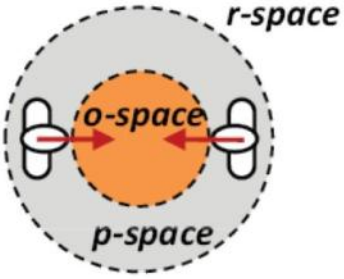
- Exploiting the notion of F-formation:

  an F-formation arises whenever two or more people sustain a spatial and orientational relationship in which the space between them is one to which they have equal, direct, and exclusive access

74

Detection of social interactions

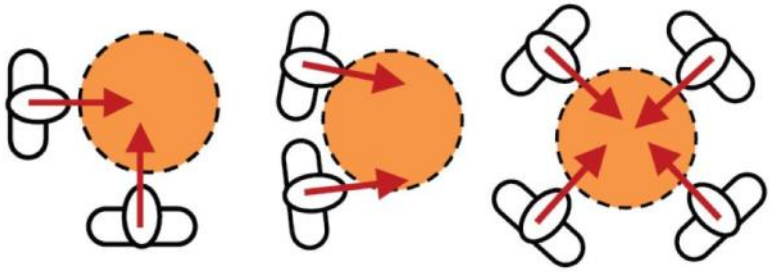
- In practice…
  - o-space: a convex empty space surrounded by the people involved in a social interaction, where every participant looks inward into it, and no external people is allowed
  - p-space: a narrow stripe that surrounds the o-space, and that contains the bodies of the talking people
  - r-space is the area beyond the p-space



75

Detection of social interactions

- Examples of F-formations



- The idea is to find such a configurations, designing a mix between an Implicit Shape Model and a Generalized Hough Voting scheme

76

Detection of social interactions

- The approach has been tested on a novel dataset, of ecologic coffee-break situations

78

Video surveillance benefits

- Another question: How many kinds of groups do exist?
- Solution: SSP may help in interpreting social cues individuating which type of group is
  - a bunch of friends
  - a family
  - a couple
  - etc.

82

Conclusions

- Social signal processing and video surveillance focus both on the same entity: *human being*
- They have different points of view for the analysis, different cues to consider
- A strict collaboration would bring advancements in both areas, opening also new perspectives
- Other work in this area
  - Vocal behavior: using turn taking and influence model
  - Crowd behavior by social force model optimization

90

Acknowledgments

This work is carried out in collaboration with:

- **Marco Cristani**
- Loris Bazzani
- Diego Tosato

92

Observing people and their behaviours

Andrea CAVALLARO
QMUL, UK

Observing people and their behaviours

Andrea Cavallaro

Professor of Multimedia Signal Processing
School of Electronic Engineering and Computer Science
Queen Mary University of London

youtube.com/smartcameras videotracking.org

Queen Mary University of London

Queen Mary University of London

One of the largest multi-faculty colleges of the University of London

- a campus-based university
- 15 minutes from central London
- 20K students

Observing people and their behaviours

Andrea Cavallaro

Professor of Multimedia Signal Processing
School of Electronic Engineering and Computer Science
Queen Mary University of London

youtube.com/smartcameras videotracking.org

Queen Mary University of London

Queen Mary University of London

One of the largest multi-faculty colleges of the University of London

- a campus-based university
- 15 minutes from central London
- 20K students

Capabilities and track record

Recent developments

Outlook

Context

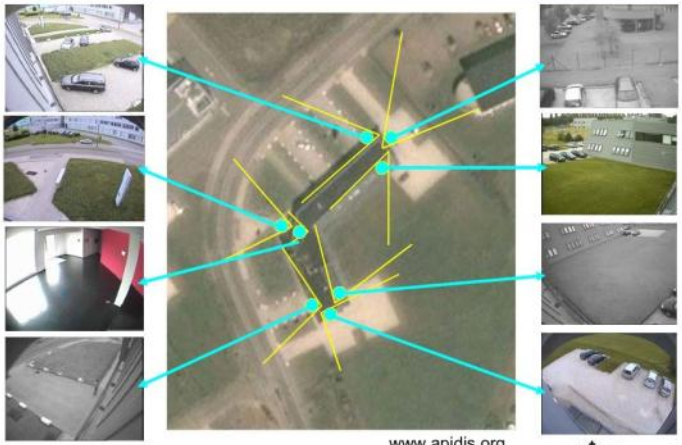
EU FP7 project APIDIS
Autonomous production of images via distributed and intelligent sensing
www.apidis.org

UK EPSRC project MOTINAS
Multi-modal object tracking in networks of audiovisual sensors
www.spevi.org

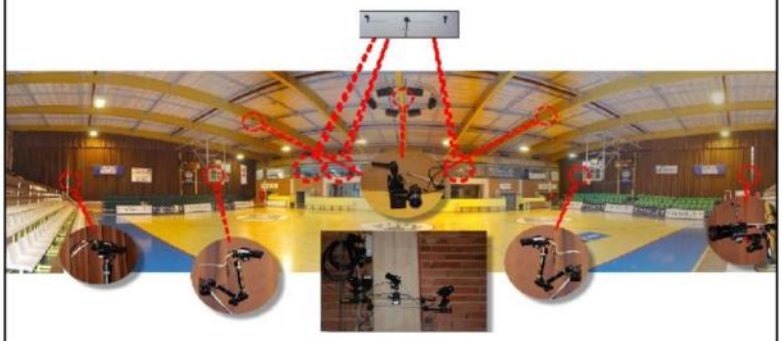
EU Erasmus Mundus Joint Doctorate ICE
Interactive and Cognitive Environments
www.icephd.org

2

Deployment example: surveillance



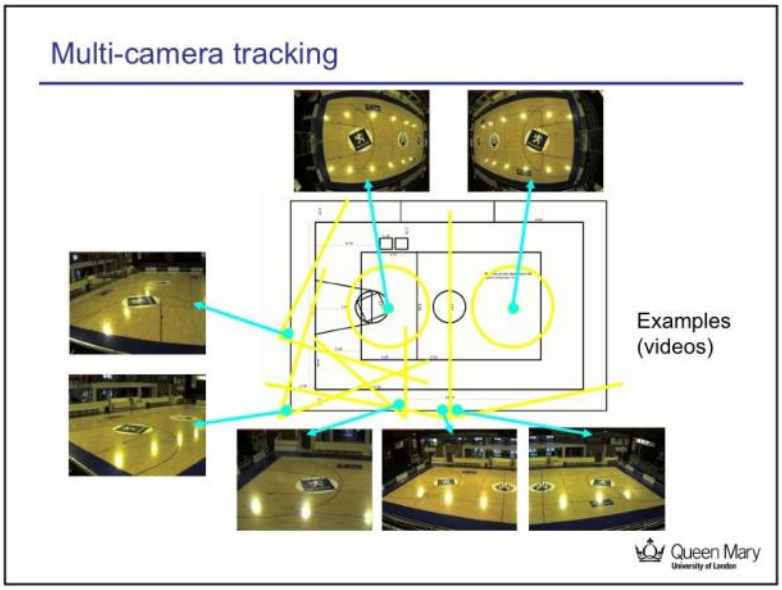
Sports: crowds, occlusions, fast changes, clutter!

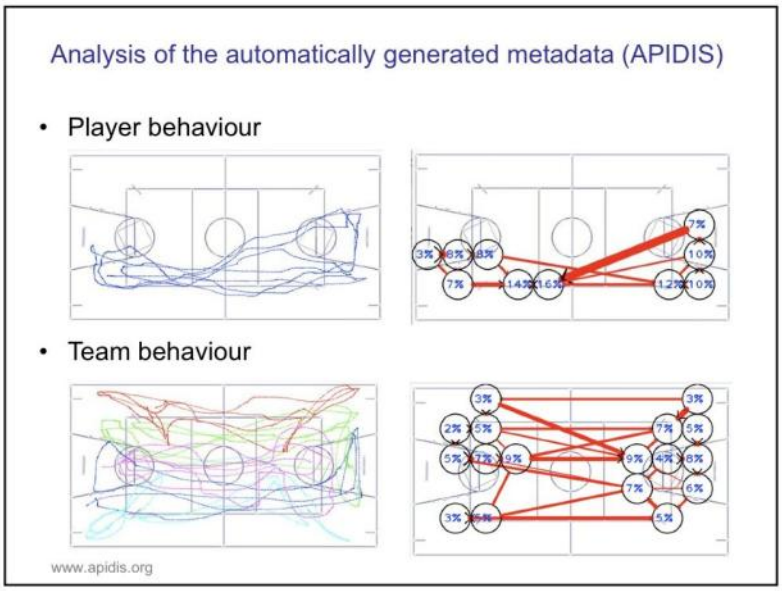


Excellent testbed for surveillance algorithms!

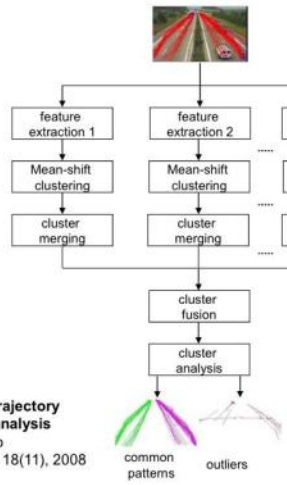
Queen Mary
University of London

3


Multi-camera tracking
Examples
(videos)
Queen Mary
University of London


Analysis of the automatically generated metadata (APIDIS)
• Player behaviour
• Team behaviour
www.apidis.org

Analysis of the automatically generated metadata



Multi-feature object trajectory clustering for video analysis
N. Anjum, A. Cavallaro
IEEE Trans. on CSVT, 18(11), 2008

Example (video)

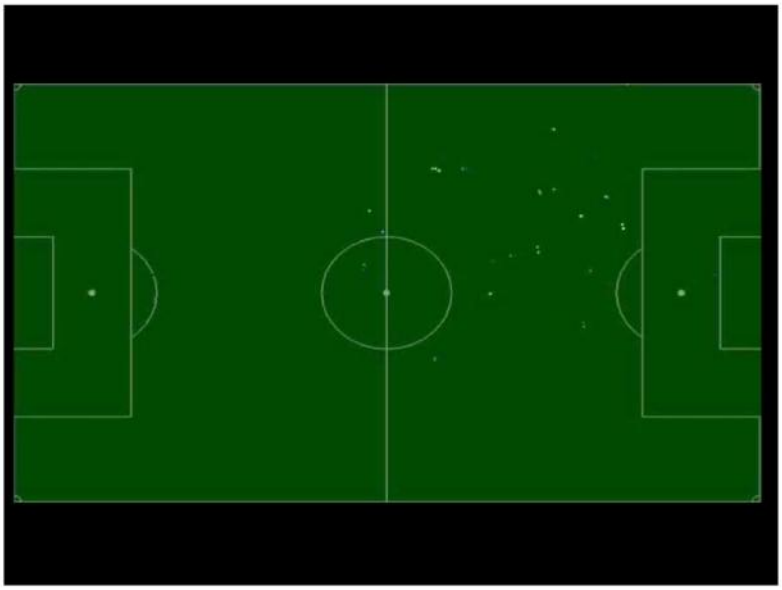
5

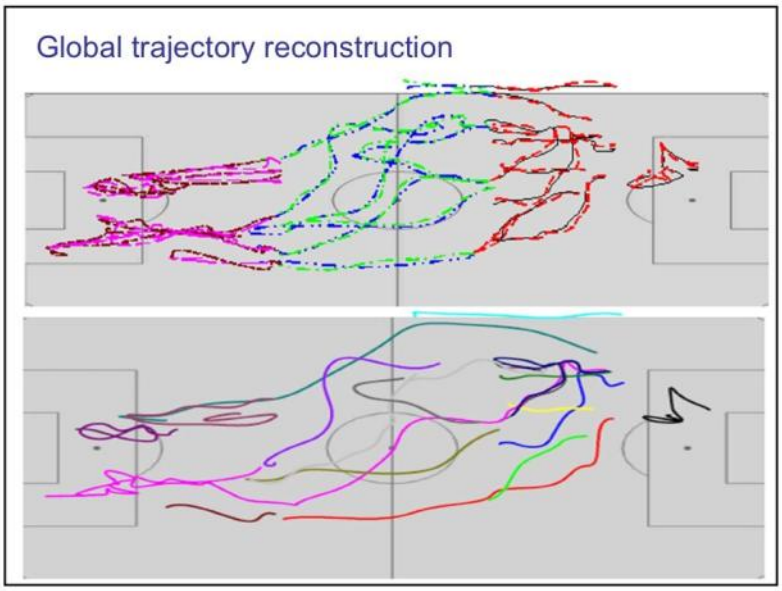

Content-aware camera ranking
with events
without events
rank
time
Blue: Inside view
Green: Outside view
Queen Mary
University of London

6

Data fusion for tracking

7



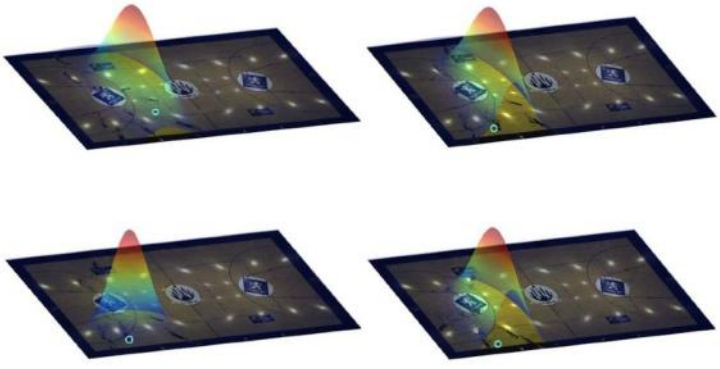


8

Trajectory association and fusion across multiple partially overlapping cameras
N. Anjum, A. Cavallaro
IEEE AVSS 2009 [best paper award]

Multi-camera track-before-detect
M. Taj, A. Cavallaro
ACM / IEEE ICDSC 2009

Unobservable event detection



Detector-less ball localization using context and motion flow analysis
F. Poiesi, F. Daniyal, A. Cavallaro
IEEE ICIP 2010

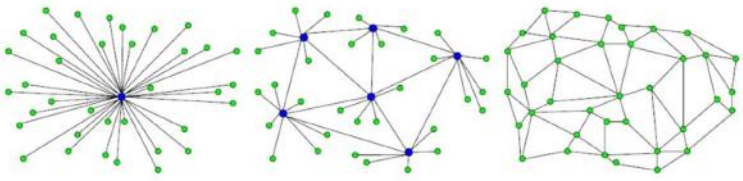
Queen Mary University of London

9

Recent developments & outlook

Scalability
Evaluation
Crowds

Scalability issues: architecture



Distributed and decentralized multi-camera tracking
M. Taj, A. Cavallaro
IEEE Signal Processing Magazine, Vol. 28, Issue 3, May 2011

Queen Mary University of London

10

Evaluation

- SPEVI
  - Surveillance Performance EValuation Initiative – www.spevi.org
  - **One-stop** web site collecting existing datasets
  - **PFT: a Protocol for Evaluating video Trackers**
    - Set of trials
    - Evaluation measure (AUC_λ)
    - Dataset

PETS00 PETS10

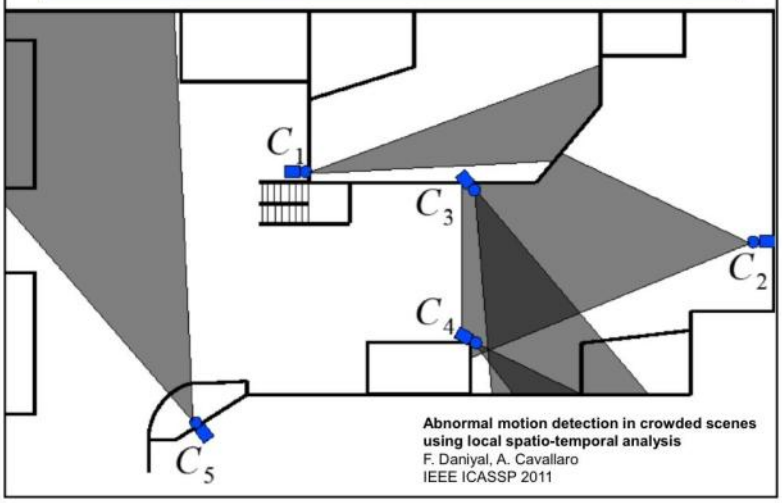
Clemson SPEVI

Software, data and results available at
http://www.eecs.qmul.ac.uk/~andrea/pft.html

PFT: a Protocol for Evaluating video Trackers
T. Nawaz, A. Cavallaro
IEEE ICIP 2011

Queen Mary University of London

Crowded scenes



Abnormal motion detection in crowded scenes using local spatio-temporal analysis
F. Daniyal, A. Cavallaro
IEEE ICASSP 2011

11

Outlook

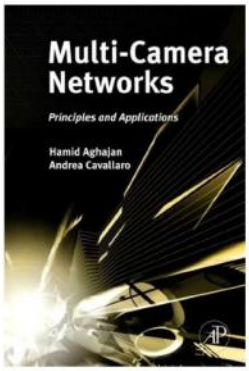
- Where are the gaps?
  - Scalability
    - how can we effectively scale up to networks of 10s, 100s sensors?
    - probabilistic description of observations, supported by multi-camera integration
    - heterogeneous sensors - video is good, but not the only modality!
  - Evaluation
    - tracking on (long-enough) "real" sequences
    - sharing of resources
    - use the same protocol!
  - Crowds
    - large-scale behaviour recognition
    - detection of unusual events
    - … while respecting the privacy of the individual!

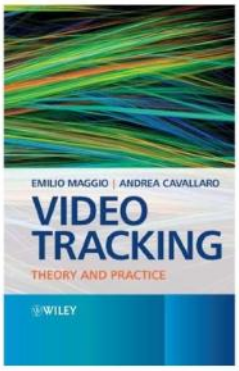
A. Cavallaro

Queen Mary University of London

References and contact information

Andrea Cavallaro
Queen Mary University of London
andrea.cavallaro@eecs.qmul.ac.uk
youtube.com/smartcameras





http://www.eecs.qmul.ac.uk/~andrea/publications.html

12

Acknowledgements

Emilio Maggio, Murtaza Taj, Gabin Kayumbi,
Nadeem Anjum, Fahad Daniyal, Fabio Poiesi,
Tahir Nawaz

The videos of the presentation are available at

www.youtube.com/smartcameras

13

Integration of multiple sensor modalities for detecting intruders in wide open areas

Rita CUCCHIARA
UNIMORE, IT

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Multi-sensor and Multi-people surveillance for detecting intruders in wide open area

Rita Cucchiara
Facoltà di Ingegneria Enzo Ferrari, Modena , Italy
ImageLab@Softech-ICT
University of Modena and Reggio Emilia, Italy

http://imagelab.ing.unimore.it

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Overview

- Presentation of Imagelab
- Wide opera area surveillance: detecting intruders
- Evidential Fusion Architecture
- Some Experimental Results

http://imagelab.ing.unimore.it

CVPR 11 COLORADO

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

Imagelab @UNIMORE

UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

UNIMORE
Funded 1175, 12 faculties 18.000 students

UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

Technopole (2009) of Emilia Romagna

Ingegneria «Enzo Ferrari» in Modena (1990)

CRIS Centro Ricerca Interdip. in Sicurezza (2007)

PIATTAFORMA MECCANICA MATERIALI

Intermech-MORE (2009)

Mechanics, Materials, Electronics, Civil, **Computer Eng.**

WebLab, DBGroup.. **ImageLab**

PIATTAFORMA ICT E DESIGN

CIRI SOFTECH-ICT (2011)

imagelab.ing.unimore.it

A recognized University Lab of the High Technology Network of Emilia Romagna

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

Research at ImageLab

UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

Machine Vision for Robotic automation

Content-based retrieval and natural interfaces for artistic digital library

Image Analysis for Medical Imaging

Multimedia systems, embedded and sensor networks

Computer Vision & Pattern Recognition for Surveillance

Video analysis for telemetry and forensics

Imagelab-Softech ICT

Since 1989..
- **Computer Vision,**
- **Pattern Recognition**
- **Multimedia**

- Softech ICT
- 50 researchers

- ImageLab
- 4 staff people
- 15 people

Spin-off **VISION-e**

http://imagelab.ing.unimore.it

CVPR 11 COLORADO

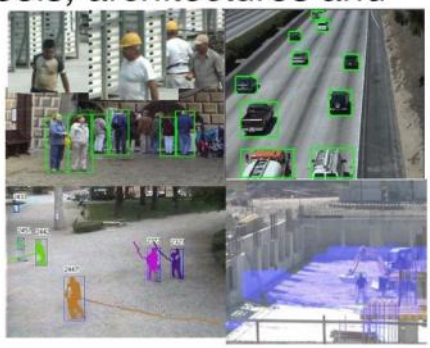
Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

Main activity: Surveillance

UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

Multi-surveillance

Models, algorithms, libraries, tools, architectures and system prototypes for



- Multi-objects,
- Multi-people,
- Multi-cameras,
- Multi-sensors..

…Multimedia Forensics and Surveillance

http://imagelab.ing.unimore.it

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

Recent projects in Surveillance

Projects:

European

- **THIS** Transport hubs intelligent surveillance EU JLS/CHIPS Project 2010-2011
- **VIDI-Video:** STREP EU → (VISOR VideoSurveillance Online Repository) 2007-2010
- **SAPHIRE** EU JLS/CHIPS Project 2010-2011

International

- **BE SAFE NATO** Science for Peace project 2007-2011
- **Detection of infiltrated objects for security** 2006-2008 Australian Council

Italian & Regional

- **Bheave_Lib :** Emilia Romagna Tecnopolo Softech 2010-2013
- **VISERAS:** Lepida ER, **IBM, Vitrocisiet,CSP**
- **LAICA** Regione Emilia Romagna; 2005-2007
- **FREE_SURF** MIUR PRIN Project 2006-2008
- **CyberStalking FCRMO** 2011
- **Paas** Acantho Distretto Tecnologico ER 2011-2012

With Companies

- **Stopped Vehicles with** Digitek Srl 2007-2008
- **SmokeWave**: with Bridge-129 Italia 2007-2011
- **People in workingsite** PRIITT **Bridge129** 2010-2012
- **Sakbot for Traffic Analysis** with Traficon 2004-2006
- **Domotica** : posture detection FCRM 2004-2005

http://imagelab.ing.unimore.it

CVPR 11 20 COLORADO 11

Projects and Prototypes (2001-2011)

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

- Tracking **vehicles in tunnels** (with Traficon, B): models, algorithms and porting on embedded
- Detecting and tracking people and vehicles with camera handoff **for access control in stadium**, (with UCSD San Diego)
- Recognizing dangerous situations and **people falls** for old and disabled people (prototype in Modena)
- Tracking and **obscuring identity** compliant with privacy f multiple people in public park, Reggio Emilia
- Experiments for **detecting unattended packs** in Sidney airport
- Trajectory analysis for **anomalous behavior** with Hebrew University, Israel
- People tracking with multiple and PTZ cameras for **people ri-identification** (ongoing with Comune of Modena)
- Video Management and Video analytic architecture of **Video surveillance as a service** (with Lepida spa ER)
- Detecting and recognizing **smoke and fires** (with Bridge 129)
- Detecting intruder in **working environments** (with Bridge 129)
- Recognizing suspicious behavior in **Banks** (with Bridge 129 ongoing)

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

Collaborations in Surveillance

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

National: *Video Surveillance & Video Analytics GIRPR Technical commettee*

International: Formal collaborations with International Universities with

Information and Communication Technologies
INTERNATIONAL DOCTORATE SCHOOL

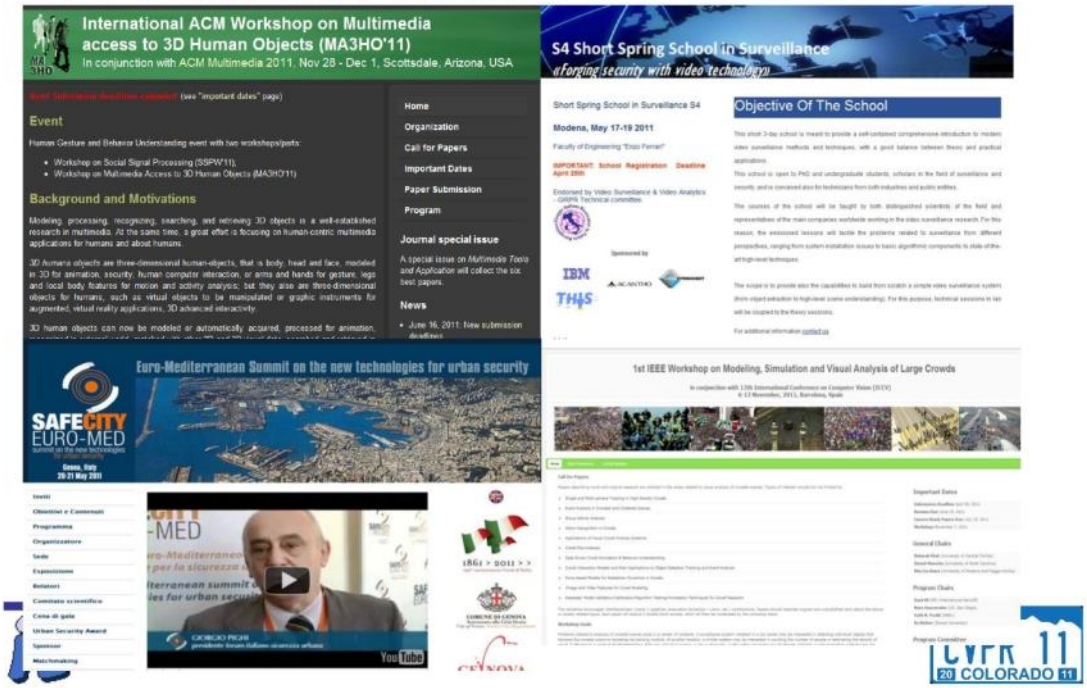
- University of Amsterdam,NL
- University of Central Florida, USA
- University of San Diego, USA
- University of Maryland, USA
- Technical University of Sidney, AU
- Computer Vision Center, Barcelona, Spain

- May 2011: S4 Short Spring School in Surveillance in Modena

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Dissemination activities



Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

UNIVERSITÀ DEGLI STUDI

ImageLab and VideoSurveillance (Ver 1.0)

- '96-99 Vehicle Detection
- and Traffic surveillance

['00 IEEE T-ITS]

- '00-02 Traffic surveillance
- With FPGA and embedded

- '02-04 Moving Object Detection (Sakbot) and Shadow Analysis

['03 IEEE T-PAMI, '03 T-PAMI]

http://imagelab.ing.unimore.it

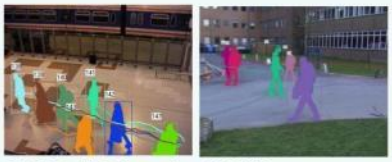
CVPR 11
20 COLORADO 11

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

ImageLab and VideoSurveillance (Ver 2.0)

UNIVERSITÀ DEGLI STUDI

- '04-.. Single Camera People Tracking



['11 PRL, '10 MTAP, '10 Annals BMVA]

- '05-..Posture ,action and
- Activity Classification

['99 IEEE T-ITS,'11 ICIP]

- '05-'08 Multicamera Consistent Labeling

['08 CVIU, '08 T-PAMI]

http://imagelab.ing.unimore.it

CVPR 11 COLORADO

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

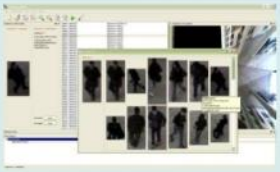
ImageLab and VideoSurveillance (Ver 3.0)

UNIVERSITÀ DEGLI STUDI

- ''06-.. Surveillance Architecture→ ViSERaS

- '10-..Actions, Activity Crowd analysis

- '09- Trajectory analysis and forensics



['11 CVIU,'11 ITCSVT]

http://imagelab.ing.unimore.it

CVPR 11 COLORADO

UNIVERSITÀ DEGLI STUDI

ImageLab and VideoSurveillance (Ver 4.0)

- '08-'11 Pedestrian Detection

['10 Eurasics j:

- '06-'07; '09-.. multisensor (Cameras + RFID) distributed surveillance

['06 JUCI]

- 3D People Re-identification

http://imagelab.ing.unimore.it

CVPR 11 20 COLORADO 11

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Examples

http://imagelab.ing.unimore.it

CVPR 11 20 COLORADO 11

13

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

Detecting objects, shadows and ghosts indoor/outdoor 2003

UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

(a) Raw image (b) SNP result (c) SP result

(d) DNM1 result (e) DNM2 result

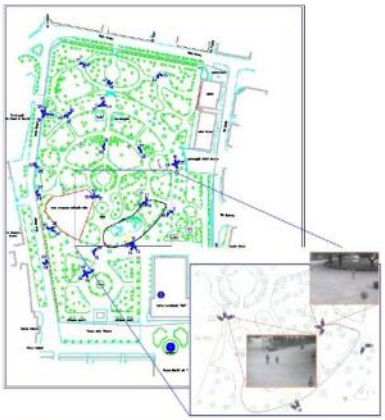
http://imagelab.ing.unimore.it

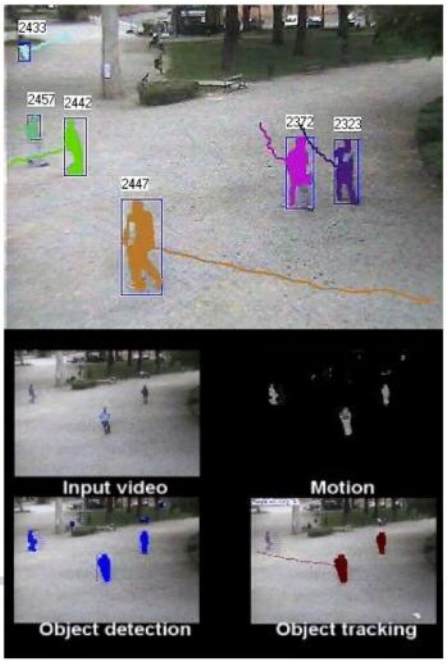
Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

Tracking people in real world 2006

UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

- Reggio Emilia
- LAICA
- Piano telematico ER

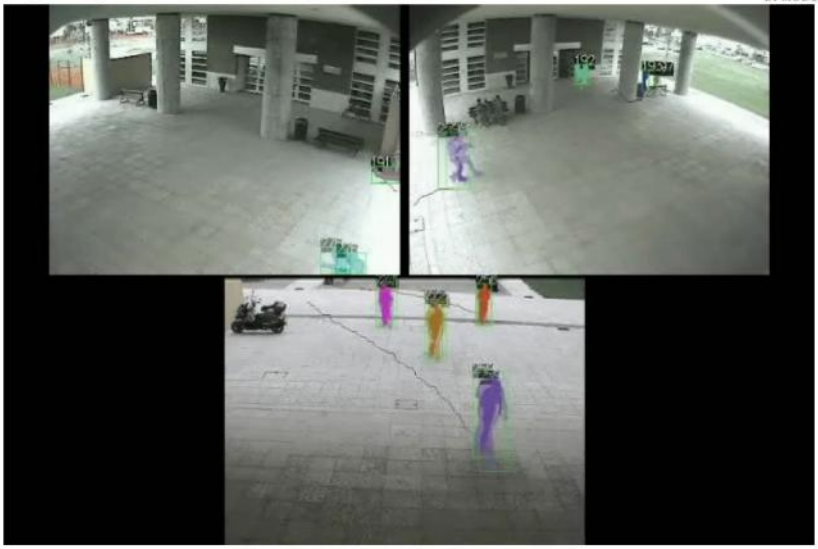




http://imagelab.ing.unimore.it

Multipeople &Multicamera

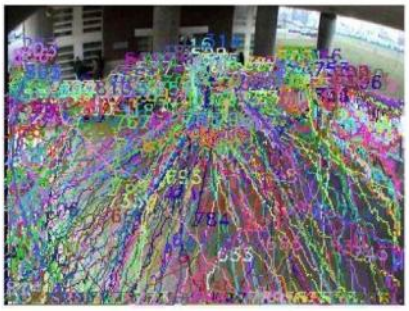
UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA



UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

People trajectory analysis

- Given all the trajectories acquired along the time in a given environment
-



Which are the trajectories that share some specific location properties?

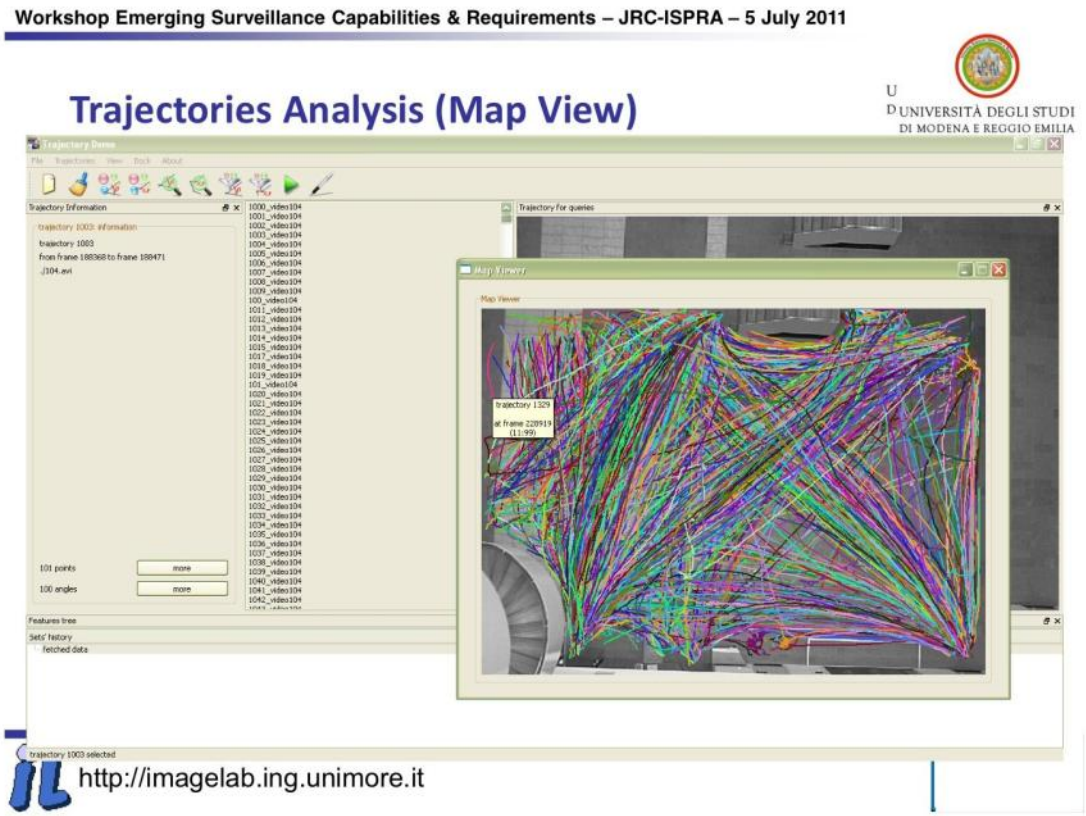
Which are the trajectories that share some specific shape properties?

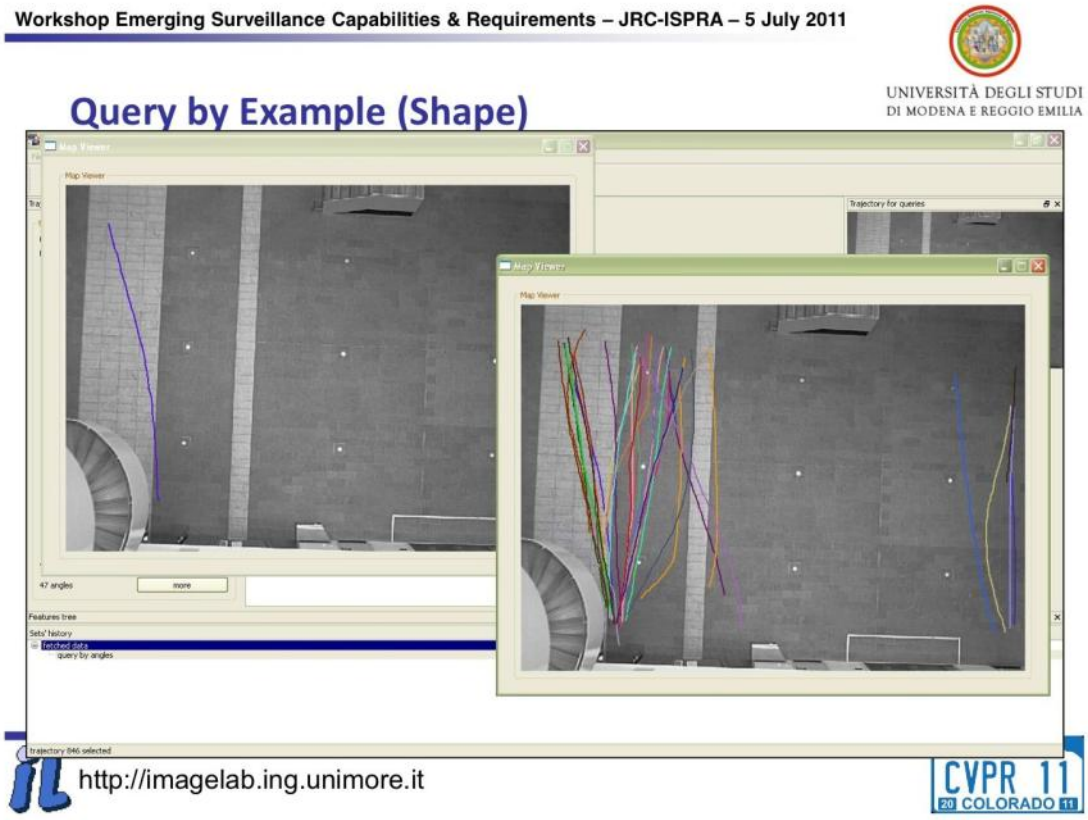
Which are The most frequent Behaviors?

Who did perform them?

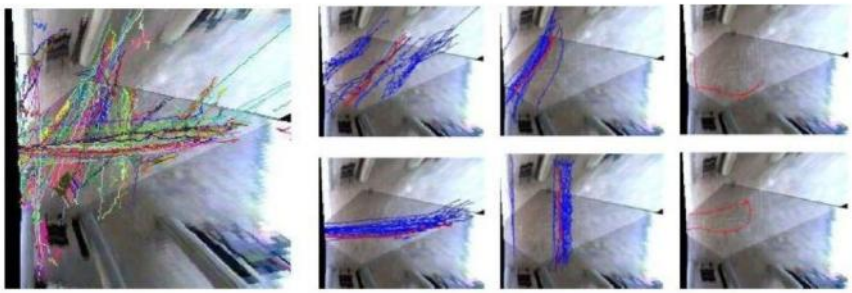
- common problems in forensics and surveillance (and in multimedia too)

Funded by NATO «Science for Peace»


Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011
Trajectories Analysis (Map View)
UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA
http://imagelab.ing.unimore.it


Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011
Query by Example (Shape)
UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA
http://imagelab.ing.unimore.it
CVPR 11
COLORADO

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA



(a) Entire dataset (b) Normal classes (c) Abnormal classes

S. Calderara, U. Heinemann, A. Prati, R. Cucchiara, N. Tishby, **"Detecting Anomalies in People's Trajectories using Spectral Graph Analysis"**
Computer Vision and Image Understanding, 2011

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Tracking, 3D Reldentification and 3D Visualization

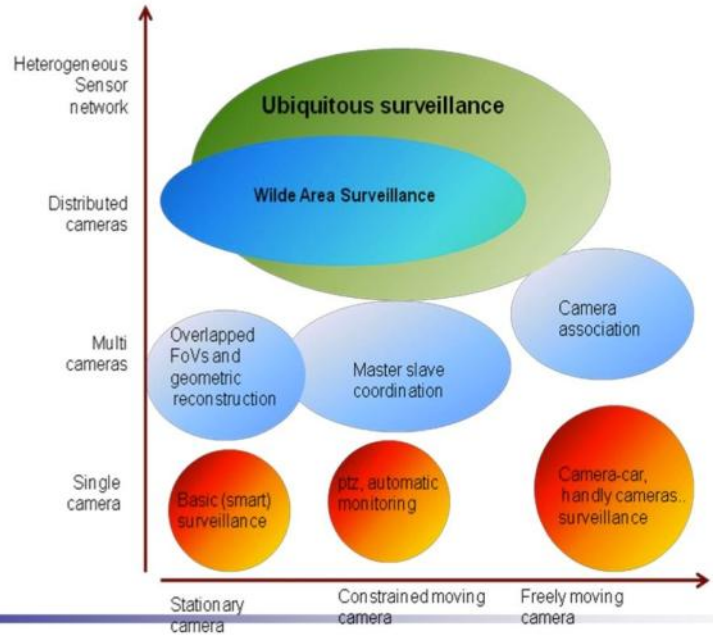
3D body models for reidentification

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Multi-sensor multi people surveillance

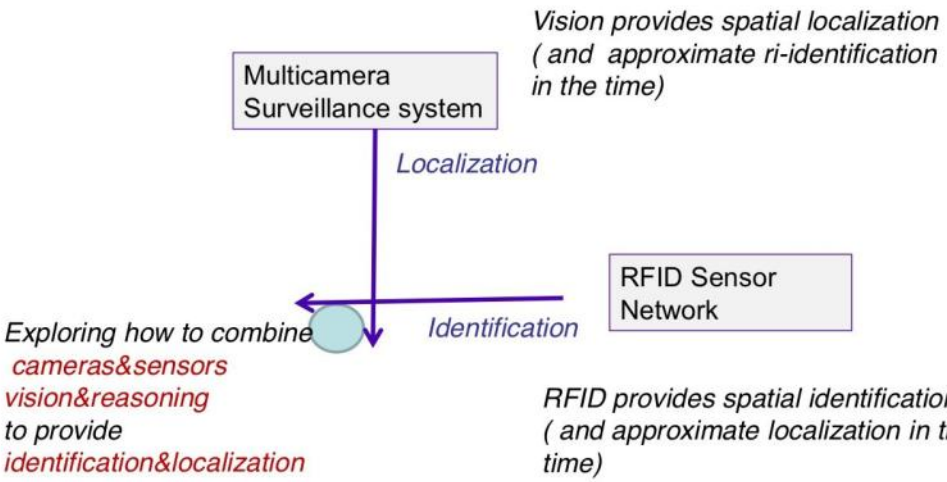
UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Wide Area Surveillance



Multipeople, Multicamera & Multisensors

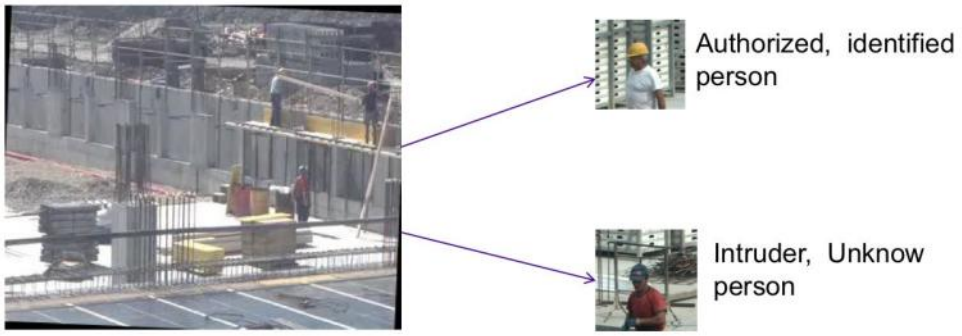
UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA



The Problem

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

- Identification&Localization for intruder people detection



Transferable Belief Model

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

The **Transferable Belief Model** is a model that represents the quantified beliefs (or weighted opinions or lack or knowledge) a person may have

There are two levels: [Smets 2000]

- the 'credal' level where beliefs are entertained
- the 'pignistic' level where beliefs are used to make decisions

:

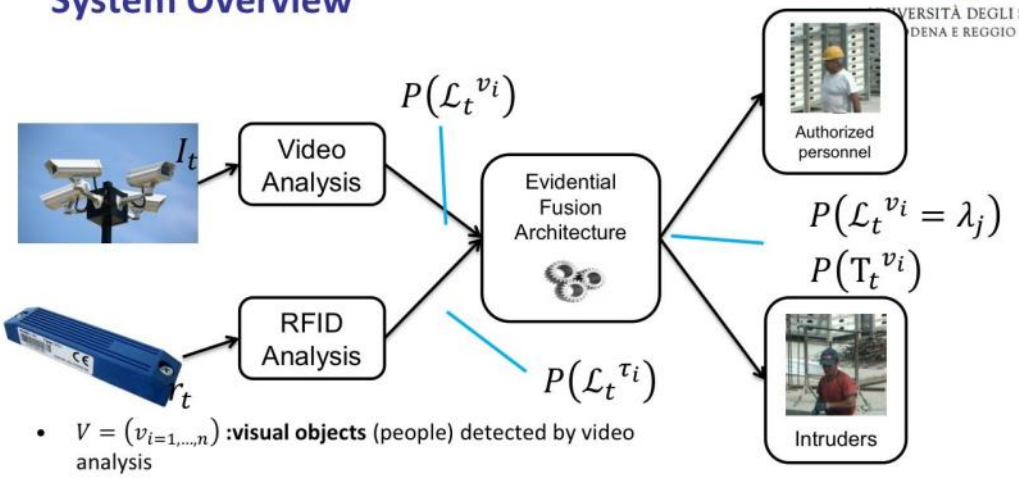
- Usually **probability belief functions** are used to quantify beliefs at both levels given the **evidences** (new information), and a **combination rule, t**hen a **pignistic transformation** makes decision
- The justification for the use of probability functions is usually linked to "rational" behavior to be held by an ideal agent involved in some decision contexts.

At
CNWSA2011 Camera Network and Wide Scene Analysis Workshop at CVPR2011 Colorado Springs
ICSDC2011 IEEE Intern Conf. on Distributed and Smart Cameras Belgium Aug 2011

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

System Overview

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA



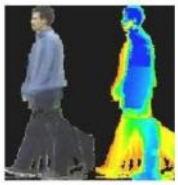
- $V = (v_{i=1,\dots,n})$ **:visual objects** (people) detected by video analysis
- $\mathrm{T} = (\tau_{i=1,\dots,s})$: *authorized* **tags** identified by RFID analysis :
- $\mathcal{L} = (\lambda_{i=1,\dots,k})$:set of **locations** in the scene to correlated data from cameras and RFIDs
- $P(\mathcal{L}_t{}^{v_i} = \lambda_j)$ the probability that object v_i is in λ_j at time t

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Video Analysis

Video Analysis

- Person ID
- Position
- Time
- Probability



Video analysis performed:

- On single camera: background suppression (SAKBOT) and object tracking (AD-HOC)
- On multiple cameras: homography- and epipolar geometry-based consistent labeling (HECOL)

[SAKBOT] R. Cucchiara, C. Grana, M. Piccardi, and A. Prati. Detecting moving objects, ghosts and shadows in video streams. **IEEE Trans. on PAMI**, 25(10):1337–1342, Oct. 2003
[AD-HOC] R. Vezzani, C. Grana, R. Cucchiara, "Probabilistic people tracking with appearance models and occlusion classification: The AD-HOC system« in **Pattern Recognition Letters**, vol. 32, n. 6, pp. 867-877, 2011
[HECOL] S. Calderara, R. Cucchiara, A. Prati, "Bayesian-competitive Consistent Labeling for People Surveillance« in **IEEE Trans on PAMI**, 30(2), pp. 354-360, 2008

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

People Localization@ImgeLab

Fixed cameras

People Segmentation
by Moving Object Detection
(SAKBOT)

People Tracking
By appearance
(AD-HOC)

People re-identification in Overlapped FoVs
by 2D/3D Consistent labeling
(HECOL)

Moving (ptz) cameras

People Tracking
by particle filtering

Any cameras

People Detection
by Classification

People long term Tracking
by Transductive Learning

People intruder recognition

People (3D) re-identification in distributed cameras

Action, behavior, event recognition

Sensor Data analsys

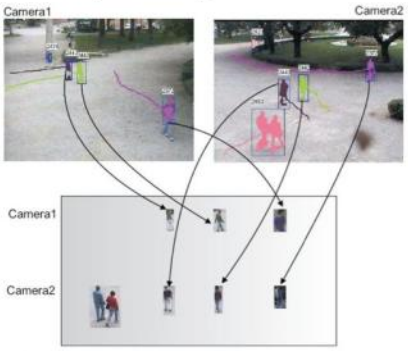
Other Sensors

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

U
D UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

People Localization

- People Segmentation Vs People detection



Video analysis
Static (multiple) cameras
Segmentation by motion
Geometry and computer vision

Image analysis
for unconstrained cameras
Detection by classification
Machine Learning and Pattern recognition

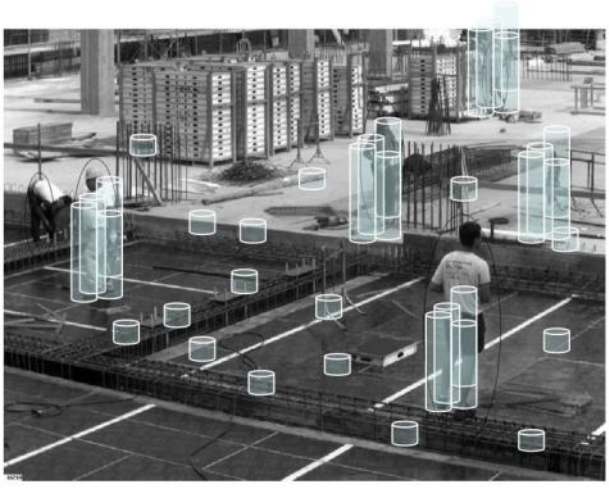
http://imagelab.ing.unimore.it

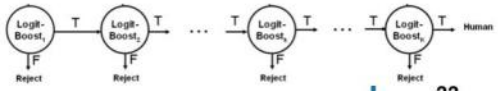
Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

U
D UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Multi-stage sampling-based pedestrian detection

A probabilistic bayesian paradigm for object detection:
"estimate obj. detection as a pdf"





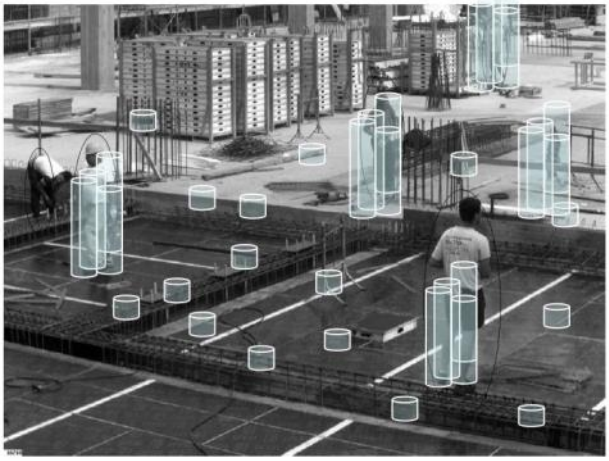
http://imagelab.ing.unimore.it

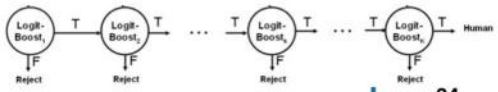
33

Multi-stage sampling-based pedestrian detection

U
D UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

A probabilistic bayesian paradigm for object detection:
"estimate obj. detection as a pdf"





Experiments in real world

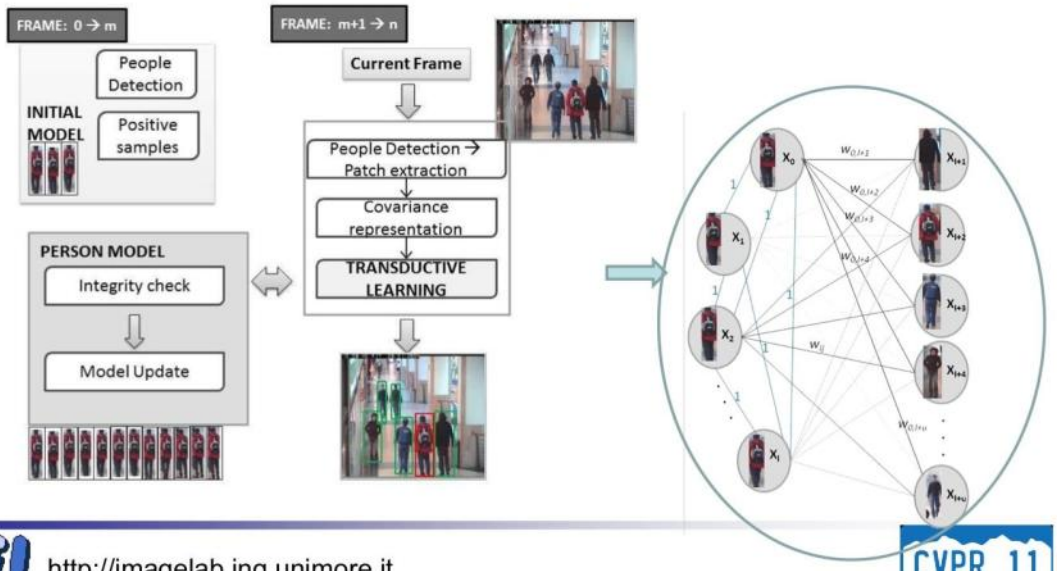
U
D UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

- Form people detection
- to head detection
- to helmet detection
- safety and security

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Trasductive learning target tracking

- tracking as a «**machine learning**» problem



http://imagelab.ing.unimore.it

CVPR 11 COLORADO

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

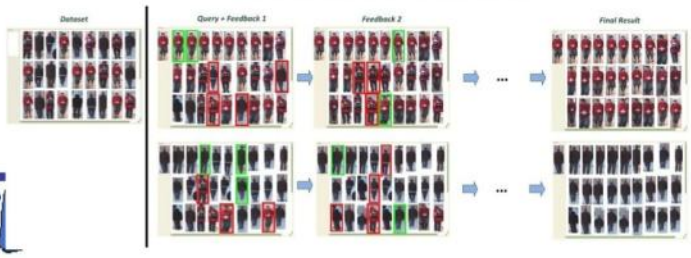
Examples

Target tracking

Details tracking in crowd

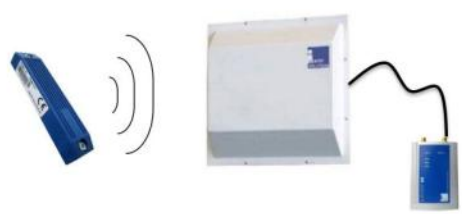
Long term Target re-identification

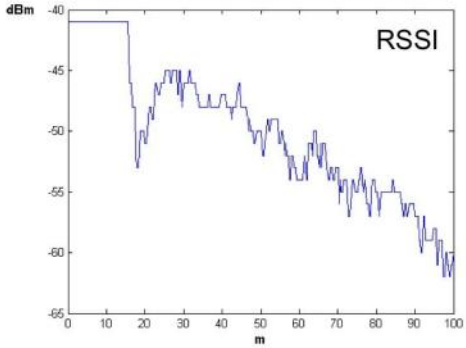
Video search with user feedback



RFID Analysis

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA





RFID Analysis

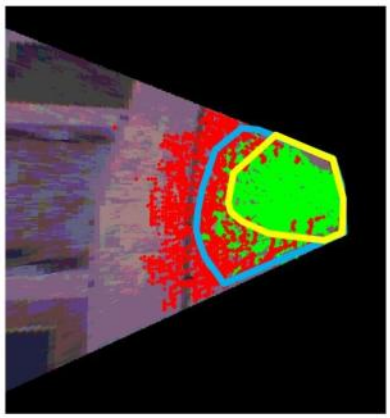
- Tag ID
- Location
- Time
- Probability

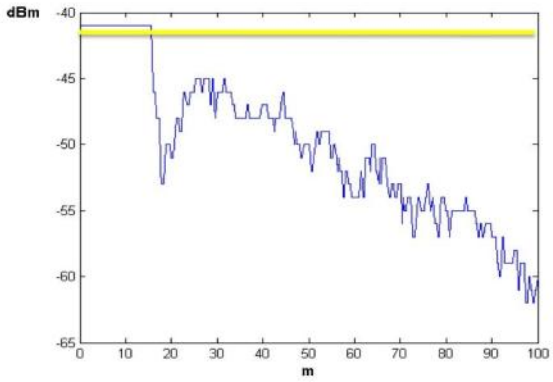
RSSI
Received Signal
Strength Indicator

Workshop Emerging Surveillance Capabilities & Requirements – JRC-ISPRA – 5 July 2011

RFID Calibration

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

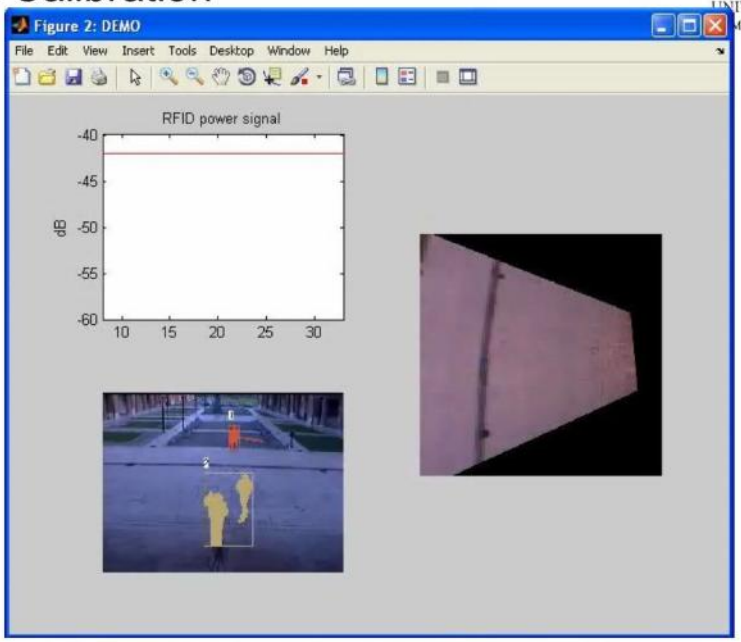




http://imagelab.ing.unimore.it
CVPR 11 COLORADO

RSSI: Calibration

UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA



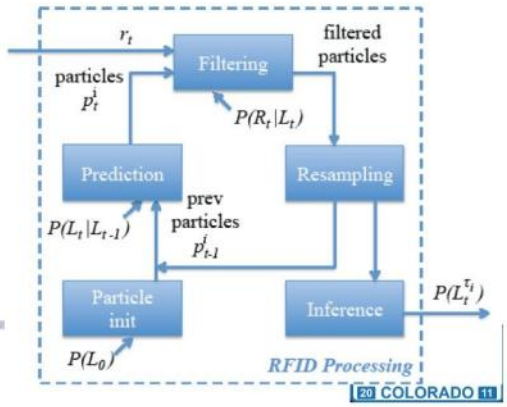
http://imagelab.ing.unimore.it

CVPR 11 COLORADO

RFID filtering

UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

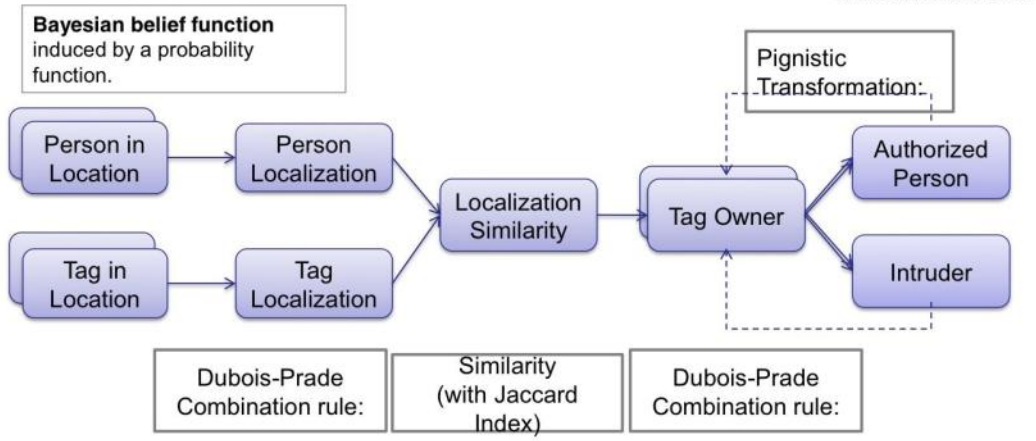
- Estimate $\mathcal{L}_t{}^{\tau_i}$ with HMM based on RSSI (Received Signal Strength Indicator) , Parameters of HMM to be learned:
  - Initial state probability $P(\mathcal{L}_0)$: uniform on locations
  - Transition probability $P(\mathcal{L}_t|\mathcal{L}_{t-1})$: a priori fixed based on scene layout
  - Observation probability $P(R_t|\mathcal{L}_t)$: learned by MLE through a training phase
- Posteriori probability
- $P\left(\mathcal{L}_t{}^{\tau_i}\right)$ is inferred using
- particle filtering



http://imagelab.ing.unimore.it

Implementation Evidential belief model

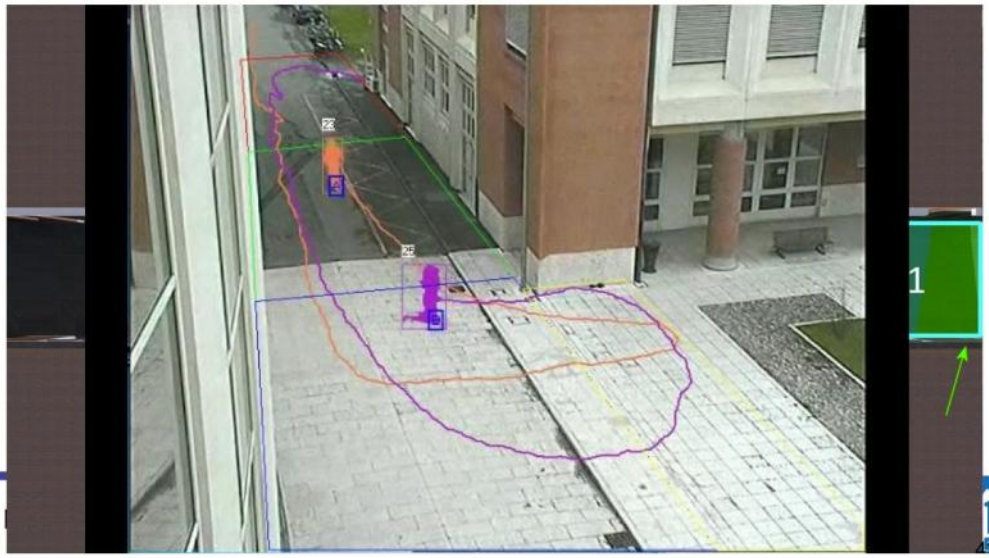
UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA



Experimental results

UNIVERSITÀ DEGLI STUDI DI MODENA E REGGIO EMILIA

- Performed on a real scenario in our campus (4 cameras, 1 antenna, 7 locations):



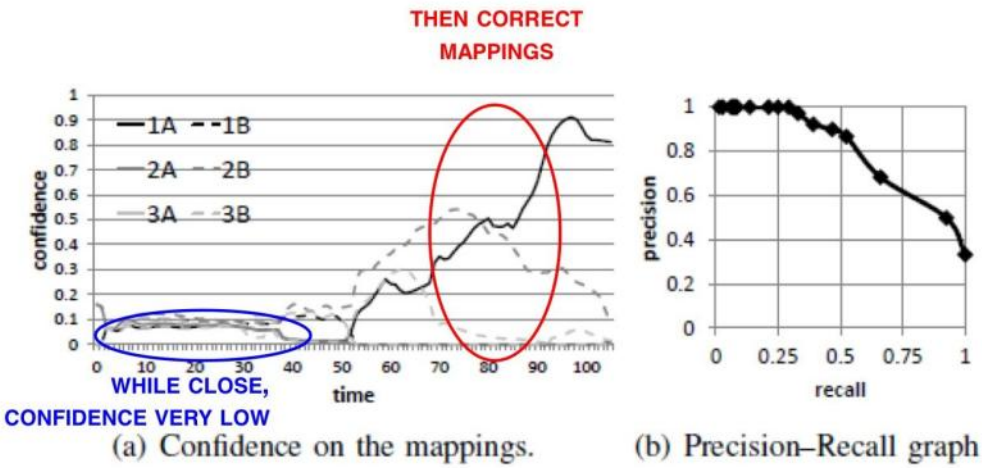
Experimental results (2)

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

- Four tests:
  - **test 1: t**mmy case
  - **test 2:** **and two intruder** se to the intruder
  - **test 3:** **and one intruder** close
  - **test 4:** **and two intruder** and one intruder

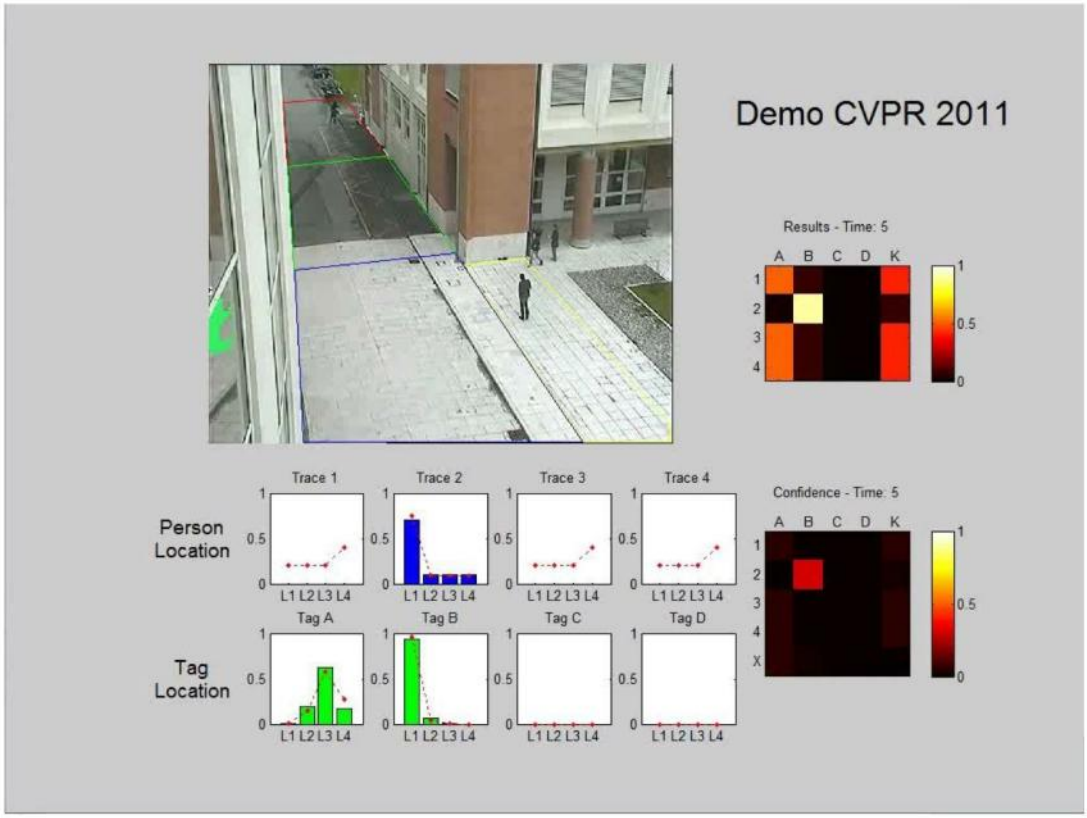
Test 3: 3 people,2 auth/1 intr.

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA



(a) Confidence on the mappings. (b) Precision–Recall graph

Correct mappings are 1A and 2B – two authorized people close



UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

Discussion

- Tracking multiple people in multiple camera is still un unsolved problem
- Many sensors can give a support for identification
- High level reasoning is necessary to filter noise and uncertainitly → achieving both identification and localization

Work in progress

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

- Working with moving (PTZ) and very high resolution cameras
- Working with embedded cameras (e.g. MOTES)
- Providing 3D re-identificiation in the time
- Providing also action-interaction analysis using aspect motion and trajectories for beahvior analysis by both far and very closed FoVs
- Scaling up number of cameras&people&sensors
- Using user interaction and RF for forensics

Thanks to Imagelab

UNIVERSITÀ DEGLI STUDI
DI MODENA E REGGIO EMILIA

http://Imagelab.ing.unimore.it
Prof. Rita Cucchiara
Dipartimento di Ingegneria dell'Informazione
Università di Modena e Reggio Emilia
+390592056136
rita.cucchiara@unimore.it

Thanks to Imagelab

ANDREA PRATI, ROBERTO VEZZANI, COSTANTINO GRANA, SIMONE CALDERARA, GIOVANNI GUALDI, PAOLO PICCININI, PAOLO SANTINELLI, DANIELE BORGHESANI, DAVIDE BALTIERI, SARA CHIOSSI, RUDY MELLI, EMANUELE PERINI, GIULIANO PISTONI, MICHELE FORNACIARI, ADNAN RASHID, ARIEL AMATO, DALIA COPPI

Next-generation communications for pervasive surveillance

Ozgur Baris AKAN
KOÇ University, TR

Next-generation Communications for Pervasive Surveillance

Prof. Ozgur B. Akan

Next-generation and Wireless Communications Laboratory (NWCL)
Department of Electrical and Electronics Engineering
Koç University
Istanbul, Turkey

N3CAT (Center for NaNoNetworking in Catalunya)
Universitat Politècnica de Catalunya
Barcelona, Spain

Outline

- About Us
- Pervasive Surveillance with Cognitive Radio Sensor Networks
- Wireless Passive Sensor Networks for Surveillance
- Collaborative Mobile Target Imaging in UWB Radar Sensor Networks
- Nano Communications for Pervasive Surveillance
- Open Issues

Short Bio (Ozgur B. Akan)

- PhD: **Georgia Institute of Technology** (2004) (School of Electrical and Computer Engineering)
- Research Interests: Wireless communications, nanoscale and quantum communications, information theory, signal processing
- Some Awards: **IEEE ComSoc Outstanding Young Researcher Award for EMEA 2010, IBM Faculty Award 2010**, METU Thesis Advisor of Year Award 2010, **IBM Faculty Award 2008,** TÜBA-GEBİP 2008, METU Outstanding Young Researcher Award 2008, AD HOC Networks Journal Editor of Year Award 2006
- Some Activities:
  - **IEEE Communications Society Distinguished Lecturer** (2011-2012)
  - **Editor,** IEEE Trans. on Vehicular Technology, Nano Communication Networks Journal (Elsevier), International Journal of Communication Systems (Wiley), European Transactions on Telecommunications, several special issues ...
  - **Organizing and TPC member** for many conferences (including IEEE INFOCOM, GLOBECOM, ICC)
  - **Tutorials** ,on "Bio-inspired and Nanoscale Communications and Networking" in many conferences (IFIP Networking 2011, IEEE Globecom 2010, Miami, FL, IEEE Sarnoff Symp. 2009, Princeton, NJ, ...)
  - **Key Member,** IEEE Multimedia Communications TC IG on "Distributed and Sensor Networks for Mobile Media Computing and Applications",
  - **Member,** IEEE Emerging TC on Nanoscale, Molecular, Quantum Communications
  - **IEEE Senior Member** (2007)
  - **Expert Reviewer**, EU-FP6/FP7/EUREKA
  - **President**, IEEE ComSoc – TR Chapter

KOÇ UNIVERSITY Next-generation Communications for Pervasive Surveillance – EU-JRC Workshop on Emerging Surveillance Capabilities and Requirements - Ozgur B. Akan 4

NWCL Crew, Collaborators, and Sponsors

Director:

Assoc. Prof. Özgür Barış Akan
Next-generation and Wireless Communications Laboratory
Department of Electrical and Electronics Engineering
Koc University
http://home.ku.edu.tr/~akan http://nwcl.ku.edu.tr
akan@ku.edu.tr

Crew:

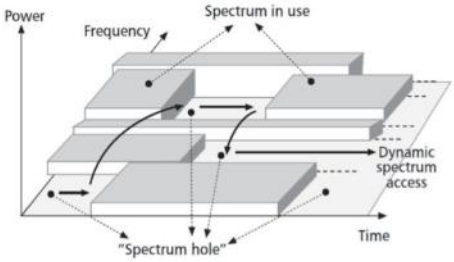
(Some) Sponsors:

(Some) Partners:

Motivation for Cognitive Radio Sensor Networks

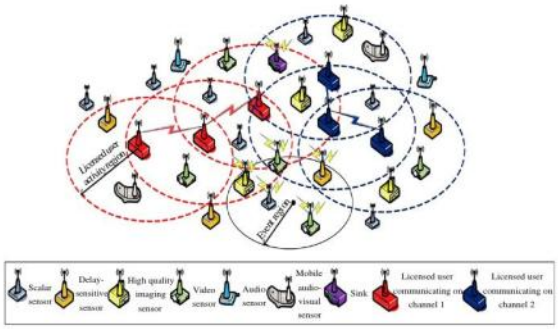
OPERATING SPECTRUM BANDS OF COMMERCIAL WSN TRANSCEIVERS AND OVERLAPPING WIRELESS SYSTEMS.

Sensor node platforms	Radio chip	Operating bands	Overlapping wireless systems
Beam , BTnode , Mica2 , MANTIS Nymph	Chipcon (TI Norway) CC1000	315, 433, 868, 915 MHz	Fixed, Mobile, Amateur, Satellite, Radiolocation, Broadcasting, Telemetry, ZigBee
IMote , MicaZ , SenseNode , XTZ , Sentilla Mini , TelosB	Chipcon (TI Norway) CC2420	2.4 GHz	Fixed, Mobile, Amateur Radio as secondary, 802.11b/g/n, Telemetry, Bluetooth, ZigBee
Mica , weC	RF Monolithics TR1000	916.3 - 916.7 MHz	Fixed, Mobile, Broadcasting, Telemetry, ZigBee
ANT	Nordic nRF24AP1	2.4 GHz	Fixed, Mobile, Amateur Radio as secondary, Telemetry, 802.11b/g/n, Bluetooth, ZigBee
EyesIFX v1 and v2	Infineon TDA5250	868 - 870 MHz	Fixed, Mobile, Broadcasting, Telemetry, ZigBee
Iris	Atmel AT86RF230	2.4 GHz	Fixed, Mobile, Amateur Radio as secondary, Telemetry, 802.11b/g/n, Bluetooth, ZigBee

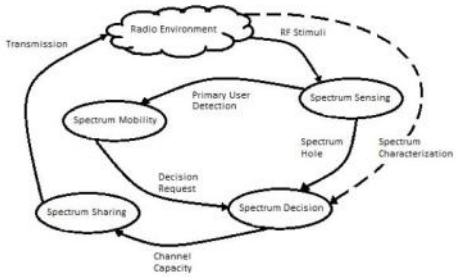


- Spectrum getting crowded → Cognitive Radio and Dynamic Spectrum Access
- Use CR features to overcome problems of constrained WSN nodes
  - Improved spectrum utilization – more network resources per energy spent
  - Access to multiple channels to conform to different spectrum regulations
  - Opportunistic channel usage – better means for event-driven bursty traffic
  - Dynamic spectrum access – Access to additional network resources
  - Inherently resilient to jamming and interference

Cognitive Radio Sensor Networks



Cognitive radio sensor network topology



- *Distributed network of wireless cognitive radio sensor nodes, which sense an event signal and collaboratively communicate their readings dynamically over available spectrum bands in a multi-hop manner ultimately to satisfy the application-specific requirements*

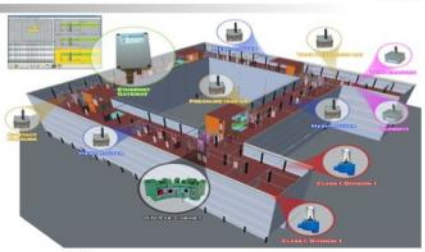
Vastly unexplored field!!!

O. B. Akan, O.B. Karli, and O. Ergul, **"Cognitive Radio Sensor Networks"**, ***IEEE Network,*** vol. 23, no.4, pp. 34-40, July 2009.

Potential Application Areas

Indoor Surveillance Applications

- Indoor channel characteristics vary more rapidly
- OSA may help improve communication reliability



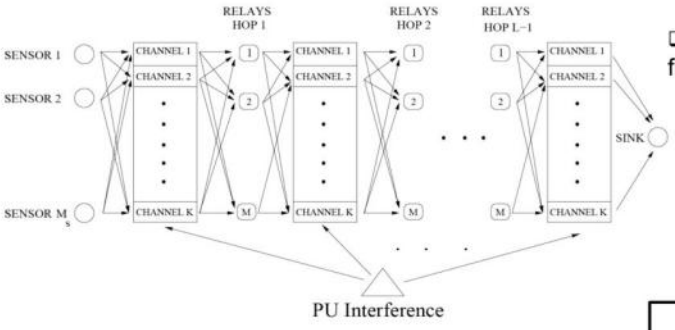
Distributed Multimedia Sensing

- Timely delivery of high bandwidth demanding signal
- Opportunistic access to high capacity channels when possible

Real-time Tactical Surveillance Applications:

- Minimum channel access and overall communication delay
- Opportunistic access to available channels to meet real-time constraints
- ***Less susceptible to interception and jamming threats***

Information Theoretical Optimization of Data Gathering in CRSN



- Power and rate adaptation framework for a multi-hop CRSN
  - information theoretical (IT) capacity maximization
  - energy adaptation (EA) and utilization of sensor data information correlations (IC)
  - CRSN characteristics: fast data aggregation, bursty traffic and node failures

- Analytical definition of optimization problem

$$\max \sum_{m,n,s,j} H\left(X_{s,j}\right) g(r,m,n,s,t) I_{s,j}(r,m,n,s,t^{+})$$

w.r.t. $I_{s,j}, W, P$ **s.t.** buffer, flow conservation, routing, power and bandwidth inequalities and equalities

$I_{s,j}$:

W, P: *Bandwidth and power variables*

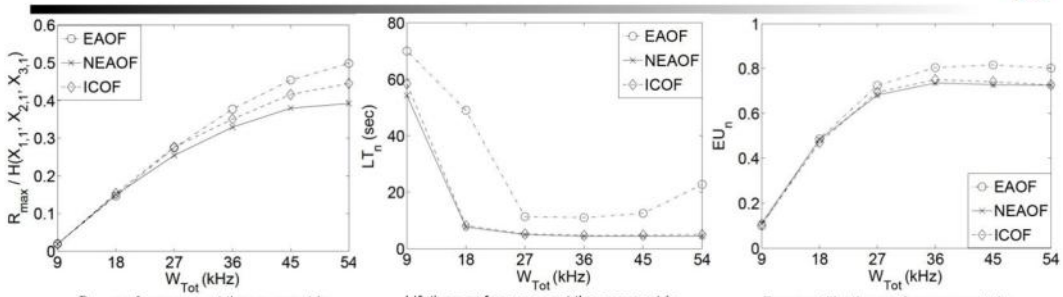
$X_{s,j}$: sample of sensor s, at t = j

$H(X_{s,j})$: entropy

$g(.)$: EA function

B. Gulbahar, O. B. Akan, "Information Theoretical Optimization of Energy Adaptive Data Gathering in Cognitive Radio Sensor Networks," to appear in **IEEE Transactions on Wireless Communications**, 2011.

Information Theoretical Optimization of Data Gathering in CRSN



R_{max} performances at the asymmetric energy level, bursty traffic.

Lifetime performances at the asymmetric energy level, bursty traffic.

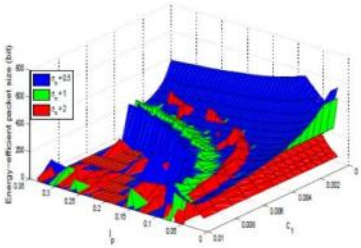
Energy utilization performances at the asymmetric energy level, bursty traffic.

- Practical schemes for objective functions (OF) utilizing ICs and EA mechanisms;
  - Branch and Bound Nonlinear Optimization Framework.
- Comparison of three different OFs: EA, utilizing IC and the one with neither of them
- Performance metrics: maximum information rate at sink, i.e., R_{max}, lifetime, and energy utilization
- Conclusions:
  - EA mechanism is better than the nonadaptive one; balancing energy consumption
  - Utilizing IC is better than not utilizing; preventing to transmit correlated data
  - Logarithmic dependence of R_{max} on total bandwidth

B. Gulbahar, O. B. Akan, "Information Theoretical Optimization of Energy Adaptive Data Gathering in Cognitive Radio Sensor Networks," to appear in **IEEE Transactions on Wireless Communications**, 2011.

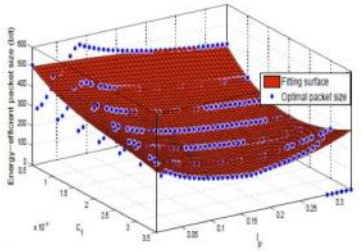
Optimal Packet Size for CRSN

❑ **Objectives:**
- ➢ Energy consumption reduction
- ➢ Enhancement of transmission efficiency
- ➢ Primary user protection
- ➢ Maintaining reliable event detection
- ➢ Realization of collaborative approaches for CRSN



❑ **Results:**

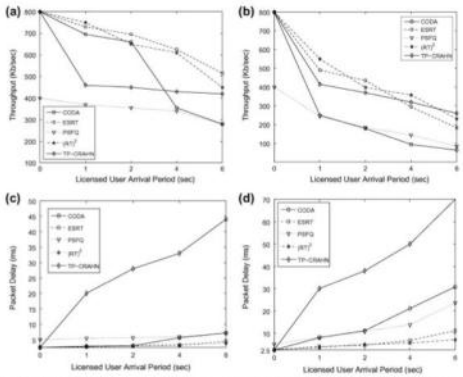
- ➢ A system model for CRSN proposed
- ➢ Packet size optimization problem w.r.t this model
- ➢ Closed-form expression of optimal packet size
- ➢ Real values of optimal packet size and fitted equation results are compared, error margin calculated
- ➢ PU behavior and BER the most critical parameters



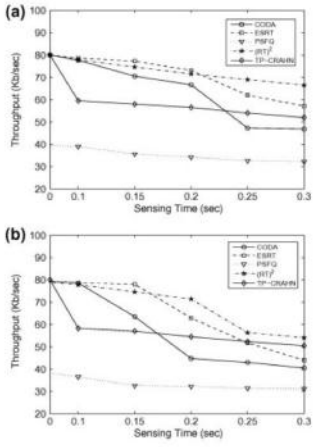
M. C. Oto, O. B. Akan, "Energy-efficient Optimal Packet Size for Cognitive Radio Sensor Networks," submitted to **IEEE Transactions on Wireless Communications**, 2011

Reliability and Congestion Control in CRSN

Analysis of the effects of PU arrivals, spectrum sensing, and cognitive cycle on opportunistic communication in CRSN



Variation of throughput, in (a) and (b), and delay, in (c) and (d), with varying PU on duration from 0 to 6 s, for constant PU off duration 6 and 3 s, respectively.



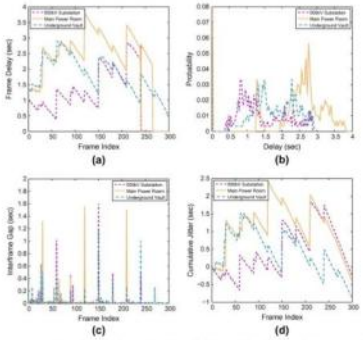
Variation of throughput while spectrum sensing duration is varying from 0 to 0.3 s for data transmission duration 3 and 2 s, in (a) and (b), respectively.

New reliability and congestion control techniques incorporating spectrum awareness and considering spatiotemporally varying spectrum characteristics are required for CRSN !!!

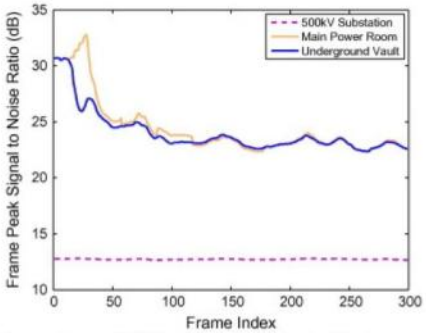
A. O. Bicen, O. B. Akan, "Reliability and Congestion Control in Cognitive Radio Sensor Networks,"***Ad Hoc Networks Journal (Elsevier)***, vol. 9, no. 7, pp. 1154-1164, September 2011. (Available online at ScienceDirect.com)

Delay-sensitive and Multimedia Surveillance

Analysis of parameters that effect delay sensitive and multimedia communication



End-to-end packet packet delay (a), pdf of end-to-end packet delay (b), inter-frame gap of received frames (c) and cumulative jitter (d) for video streaming in CRSN.



Frame PSNR values of received video in different power grid environments

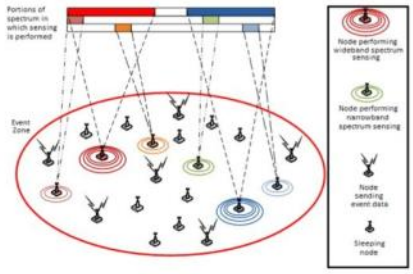
- *Spectrum-aware Versatile Event Transport in CRSN (S-VETs)*

A novel, adaptive transport layer suite for CRSN, S-VETs is designed for both delay-insensitive and real-time collaborative event sensing in CRSN.

A. O. Bicen, V. C. Gungor, O. B. Akan, "Delay-sensitive and Multimedia Communication in Cognitive Radio Sensor Networks," to appear in ***Ad Hoc Networks Journal (Elsevier)***, 2011.

Composite Spectrum Sensing for CRSN

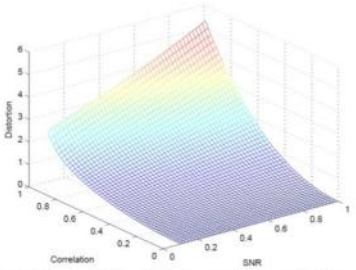
- Energy-efficient, yet simple methods needed.
- Two stage sensing:
  - Wideband sensing based on sequential testing: Run length gives an estimate of the more promising channels
  - Cooperative narrowband sensing using correlation: Correlation (ρ) causes "*distortion*" *(D)* in decision statistic (l). Choose nodes with low distortion!



$$D = E[(l_{uncor} - l_{cor})^2]$$

$$l_{uncor} = \frac{1}{2}\left(r_1^2 + r_2^2\right)\frac{\gamma}{1+\gamma}$$

$$l_{cor} = \frac{1}{2}\left(r_1^2 + r_2^2\right)\left[1 - \frac{1+\gamma}{(1+\gamma)^2 - \rho^2}\right] + r_1 r_2\left[1 - \frac{\rho}{(1+\gamma)^2 - \rho^2}\right]$$



O. Ergul, O.B. Akan, "A Composite Spectrum Sensing Scheme for Cognitive Radio Sensor Networks," submitted to **IEEE Transactions on Wireless Communications**, 2011.

Main Challenge in Sensor Networks

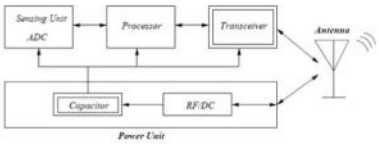
Limited Network Lifetime

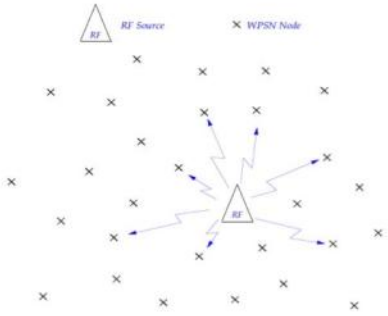
- Sensor nodes resource-constrained
- Main focus: Development of energy-efficient communication protocols and computing algorithms
- Problem: When batteries deplete, operations stop
- Recharging or changing the batteries impractical

Processor/Radio	MPR300CB
Speed	4 MHz
Flash	128K bytes
SRAM	4K bytes
EEPROM	4K bytes
Radio Frequency	916/433MHz (ISM)
Data Rate	40 Kbps (Max)
Power	0.75 mW
Radio Range	100 feet (prog.)
Power	2 x AA batteries

A Different Approach: ***Wireless Passive Sensor Networks***

- RF energy: Main source of power
- Communication via Modulated Backscattering
- Power Unit: No battery, only an RF-DC Converter + (Ultra)Capacitor
- Transmitter: A single switch





KOÇ UNIVERSITY

Wireless Passive Sensor Networks

Networked Modulated Backscattering & Research Avenues

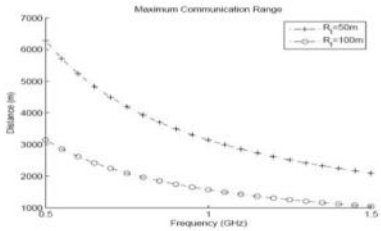
Sources emit 4W EIRP, passive nodes employ half-wave dipoles

- At f=1GHz and RF source at 100m

Range = *1572m*

- When RF source is also the sink:

Range = *396m*



Already Achieved

- Introduction of WPSN and its research challenges
- Communication Coverage Analysis
- A Modulated Backscattering-based Communication Protocol
- Error Control in WPSN

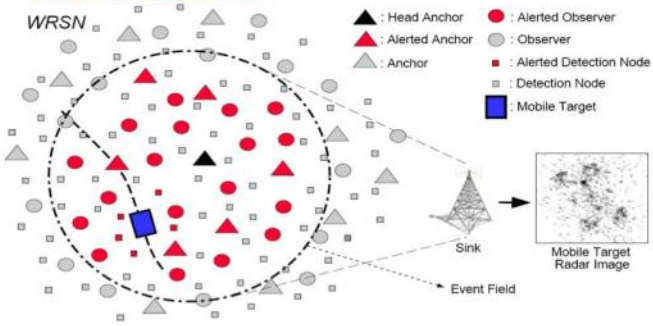
WPSN idea can be applied for video surveillance under Emergency conditions (e.g., subway surveillance when there's a power outage)

O. B. Akan, M. T. Isik, B. Baykal, "Wireless Passive Sensor Networks", ***IEEE Communications Magazine****, August 2009.*
A. Bereketli, O. B. Akan, "Communication Coverage in Wireless Passive Sensor Networks", ***IEEE Communications Letters****, February 2009.*
M. T. Isik, O. B. Akan, "PADRE: Modulated Backscattering-based PAssive Data REtrieval in Wireless Sensor Networks", ***IEEE WCNC 2009****, April 2009.*

KOÇ UNIVERSITY

Collaborative Mobile Target Imaging in UWB WRSN

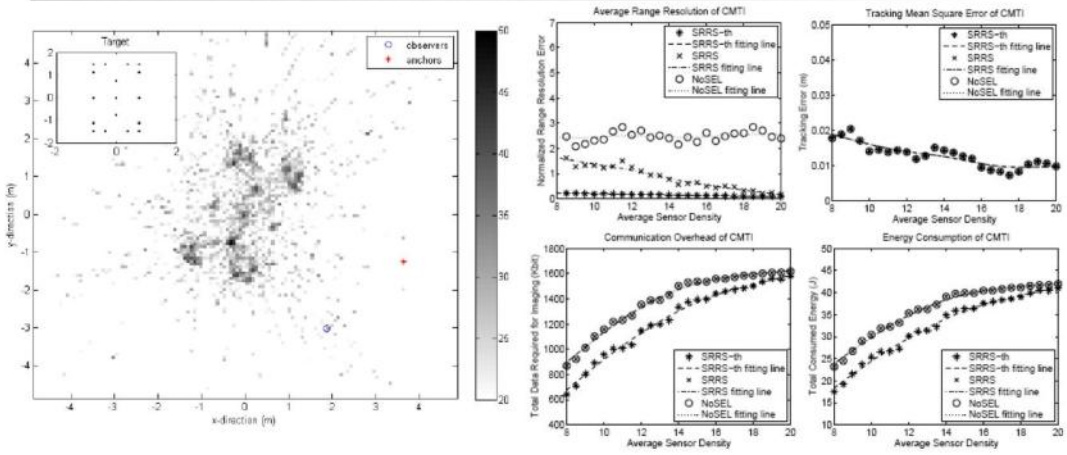
- UWB Wireless Radar Sensor Network (WRSN) enabling technology for border surveillance in homeland security
- More reliable radar fences to protect critical infrastructures
- UWB enables WRSN to
  - static object localization and imaging
  - mobile target detection, tracking and imaging …
- *Accurately and efficiently obtain an image of mobile targets based on the collaborative effort of UWB WRSN nodes.*



Really practical???

Arik, M.; Akan, O.B.; , "Collaborative mobile target imaging in UWB wireless radar sensor networks," ***IEEE JSAC***, vol.28, no.6, pp.950-961, Aug. 2010

Collaborative Mobile Target Imaging in UWB WRSN



- CMTI obtains high quality radar image of mobile targets with very low communication overhead, reliability and energy expenditure utilizing FEC.
  - Experiment results show that performance not affected by the shape and velocity of mobile targets

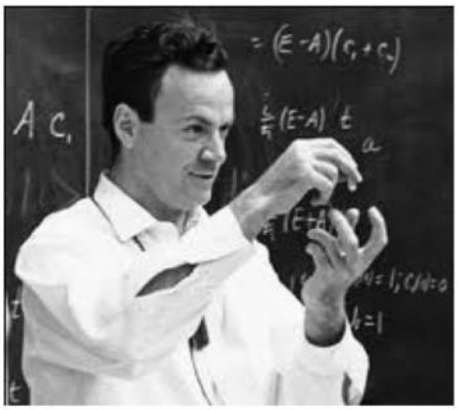
M. Arik, O. B. Akan, "Collaborative mobile target imaging in UWB wireless radar sensor networks," ***IEEE Journal on Selected Areas in Communications (JSAC)***, vol.28, no.6, pp.950-961, August 2010

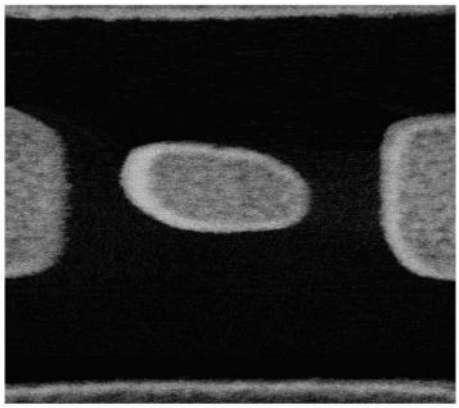
Miscellaneous Work on Multimedia Communications

- G. Isbitiren, O. B. Akan, "3D Underwater Target Tracking with Acoustic Sensor Networks," to appear in ***IEEE Transactions on Vehicular Technology***, 2011.
- B. Atakan, O. B. Akan, "Distributed Audio Sensing with Homeostasis-inspired Autonomous Communication," ***Ad Hoc Networks Journal (Elsevier)***, vol. 9, no. 4, pp. 552-564, June 2011.
- M. T. Isik, O. B. Akan, "A Three Dimensional Localization Algorithm for Underwater Acoustic Sensor Networks," ***IEEE Transactions on Wireless Communications***, vol. 8, no. 9, pp. 4457-4463, September 2009.
- V. C. Gungor, O. B. Akan, and I. F. Akyildiz, "A Real-Time and Reliable Transport Protocol for Wireless Sensor and Actor Networks," ***IEEE/ACM Transactions on Networking***, vol. 16, no. 2, pp. 359-370, April 2008.
- V. C. Gungor, O. B. Akan, "Delay-Aware Reliable Communication in Wireless Sensor Networks," ***International Journal of Communication Systems (Wiley),*** vol. 20, no. 10, pp. 1155-1177, October 2007.
- O. B. Akan, "Performance of Transport Protocols for Multimedia Communications in Wireless Sensor Networks," ***IEEE Communications Letters ,*** vol. 11, pp. 826-828, October 2007.
- E. Gurses, O. B. Akan, "Multimedia Communication in Wireless Sensor Networks," ***Annals of Telecommunications*** , vol. 60, no. 7-8, pp. 799-827, July-August 2005.
- I. F. Akyildiz, O. B. Akan, G. Morabito, "A Rate Control Scheme for Adaptive Real-Time Applications in IP Networks with Lossy Links and Long Round Trip Times," ***IEEE/ACM Transactions on Networking***, vol. 13, no. 3, pp. 554-567, June 2005.

KOÇ UNIVERSITY Next-generation Communications for Pervasive Surveillance – EU-JRC Workshop on Emerging Surveillance Capabilities and Requirements - Ozgur B. Akan

"There's a plenty of room at the bottom"





Is the room down there sufficient for a surveillance network?

KOÇ UNIVERSITY Next-generation Communications for Pervasive Surveillance – EU-JRC Workshop on Emerging Surveillance Capabilities and Requirements - Ozgur B. Akan 20

WSN vs. WNSN for Surveillance

- Limitations of Wireless Sensor Networks (WSN)
  - Network Lifetime
  - Size
  - Sensing Capabilities
- ***Wireless Nanosensor Networks (WNSN)***
  - Much smaller
  - Less power hungry
  - More sensitive
  - Aligned with Internet of Things and Internet of nanosensing Things
- **Many applications of WNSN**
  - Intra-body nanosensor networks
  - Chemical and biological attack detection and preventation
  - Large-scale integrated surveillance
- **Communication paradigms for WNSN**
  - Carbon-nanotube (CNT) or Graphene-based Nano-EM communications
  - Molecular communications

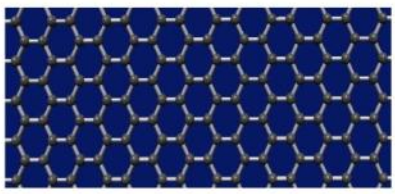
Nanomaterials: Graphene, Nanotubes & Nanoribbons

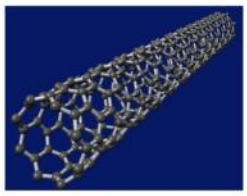
Graphene: A one-atom-thick planar sheet of bonded carbon atoms in a honeycomb crystal lattice.

- *Carbon Nanotubes (CNT)*: A folded nanoribbon (1991)
- *Graphene Nanoribbons (GNR)*: A thin strip of graphene (2004)

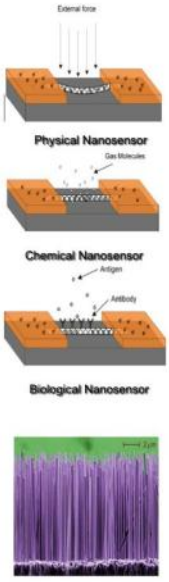
* High current capacity + High thermal conductivity → Energy efficiency
* Extremely high mechanical strength → Robustness
* Very high sensitivity (all atoms are exposed) → Sensing capabilities

New opportunities for device-technology:
Nano-batteries, nano-memories, nano-processors, nano-antennas, nano-tx, nano-rx.



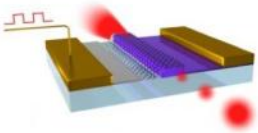


Nanosensor Node Units

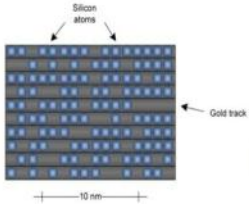


High density Zinc Oxide nano-wires for **nano-battery**

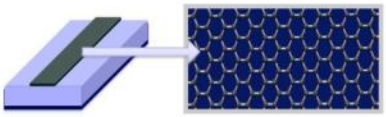
False-colour scanning electron microscopy image of a programmable nanowire **nanoprocessor**. Image Credit: Charles M. Lieber. (Feb 2011, Harvard & MITRE Corp.)



Entire graphene circuit for broadband radio-frequency mixer, a fundamental component of **nanoradios** (IBM funded by DARPA for high-frequency military communications equipment).



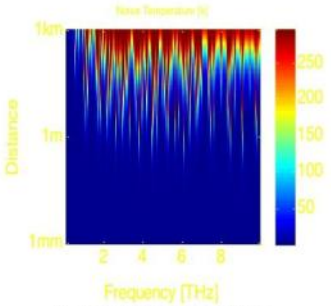
5x5x5 atoms used to store a bit in **nano-memory** and to avoid inter-atom interference



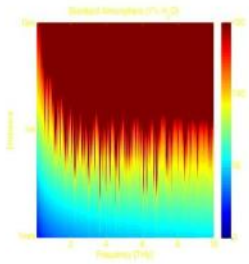
Graphene can be used to manufacture **nano-antennas** with atomic precision.
Using nano-antennas, EM waves will be radiated in the Terahertz Band (0.1-10 THz).

TeraHertz Band for Electromagnetic WNSN

- Terahertz communication channel has a strong dependence on
  - * the transmission distance
  - * the medium molecular composition.
- Main factor affecting the performance of the Terahertz band
  - * the presence of water vapor molecules.
- THz band offers huge bandwidths for short range (less than 1m) deployed nanonetworks



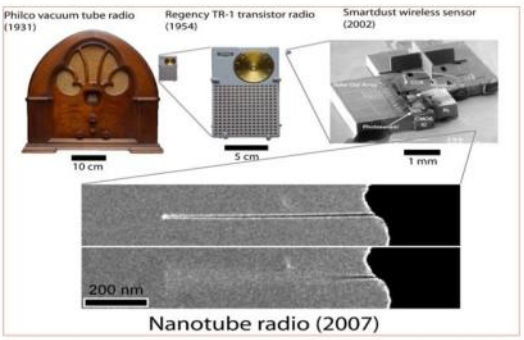
Molecular Absorption Noise

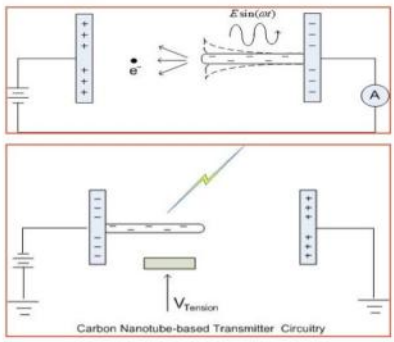


Total path loss

J.M. Jornet and I.F. Akyildiz, "Channel Capacity of Electromagnetic Nanonetworks in the Terahertz Band", **Proc. of IEEE ICC 2010**, May 2010.

Nano-EM Communications with CNT Radio



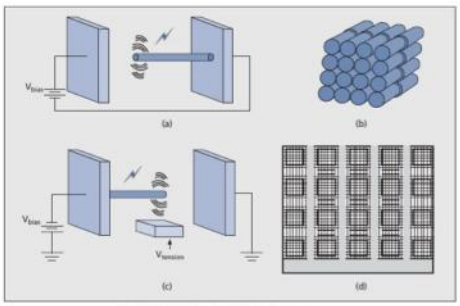


K. Jensen, J. Weldon, H. Garcia, A. Zettl, "Nanotube Radio", **Nano Letters**, vol. 7, pp. 3508-3511, 2007.

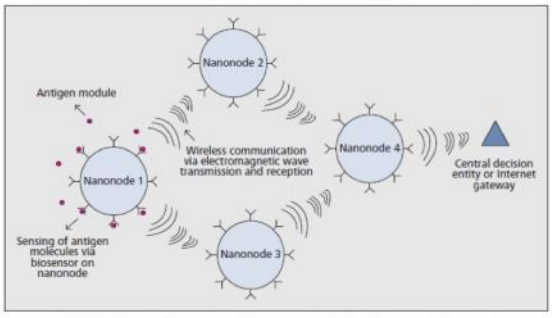
- Antenna, tuner, demodulator, amplifier of a radio with a single nanotube
  - Signal reception, tuning, amplification, demodulation electromechanical processes
- CNT resonance frequency must match carrier ω_c (affected by nanotube length)
  - Nanotube length degrades with field emission current as well
- FM modulation (transmitter) by applying info signal to external electrode ($V_{tension}$)

B. Atakan, O.B. Akan, "Carbon Nanotube-based Nanoscale Ad Hoc Networks", **IEEE Communications Magazine**, vol. 48, pp. 129-135, June 2010
B. Atakan, O.B. Akan, "Carbon Nanotube Sensor Networks," in **Proc. IEEE NanoCom 2009**, San Francisco, USA, August 2009.

CNT-based Nanoscale Ad Hoc Networks (CANET)



CANET Node Hardware



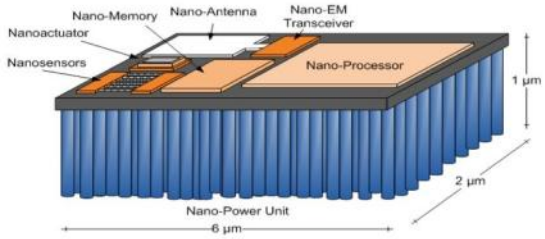
A CANET Application: Nanoscale Bio-Sensor Network

- Extremely challenged wireless ad hoc communication domain
- Medium's molecular composition affects communication rate and range
- High power required by nanotube radio: crucial challenge for realization

B. Atakan, O. B. Akan, "Carbon Nanotube-based Nanoscale Ad Hoc Networks", **IEEE Communications Magazine**, vol. 48, pp. 129-135, June 2010.

Carbon Nanotube Sensor Networks (CNSN)

- Many nanodevices at early stages of their development
- To harness their unique features, the objective is to combine them in unified a system architecture
- CNT sensor node hardware includes many fundamental components:
  - Nano-transceiver
  - Nano-power unit
  - Nano-processor and memory
  - Nano-sensing units

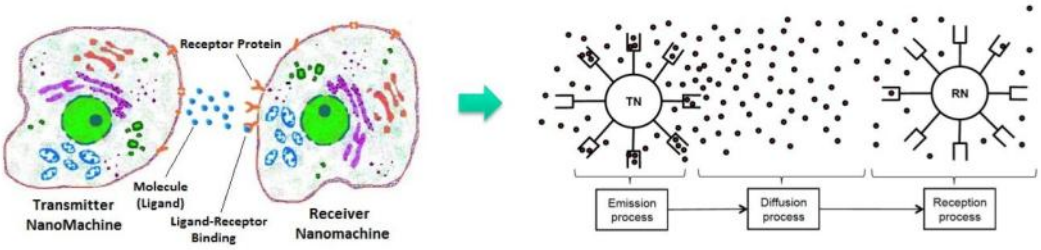


I. F. Akyildiz, J.M. Jornet, "Electromagnetic Wireless Nanosensor Networks," **Nano Communication Networks Journal**, vol. 1, pp.3-19, March 2010.

Extremely limited power, data storage, computation, and synchronization capabilities severely restrict CNT sensor communication

B. Atakan, O. B. Akan, "Carbon Nanotube Sensor Networks", in **Proc. IEEE NanoCom 2009**, San Francisco, CA, August 2009.

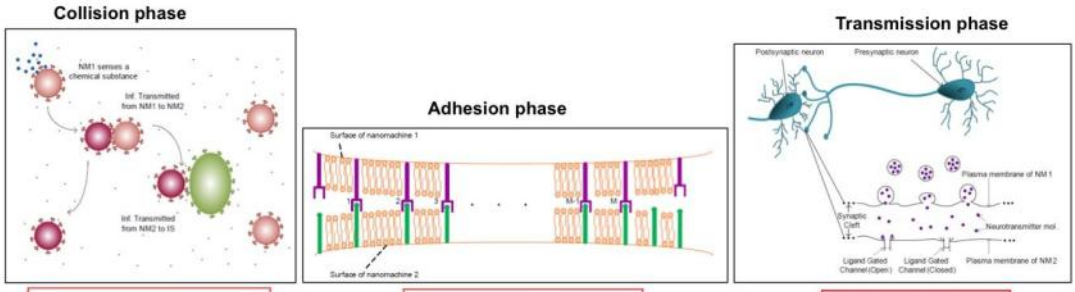
Nanosensor Networks with Molecular Communication



- Biological entities communicate with ligand-receptor binding mechanism
- Information encoded in the concentration (or type) of molecules
- Single/relay/multiple access/broadcast channel modeling based on diffusion

A. Guney, B. Atakan, O. B. Akan, "Mobile Ad Hoc Nanonetworks with Collision-based Molecular Communication," to appear in **IEEE Transactions on Mobile Computing**, 2011.
B. Atakan, O. B. Akan, "Deterministic Capacity of Information Flow in Molecular Nanonetwork", **Nano Communication Networks Jrnl.**, vol. 1, pp. 31-42, 2010.
B. Atakan, O. B. Akan, "An Information Theoretical Approach for Molecular Communication", **IEEE/ACM BIONETICS 2007**, Budapest, Hungary, 2007.
B. Atakan, O. B. Akan, "On Channel Capacity and Error Compensation in Molecular Communication", **Springer Trans. Comp. Systems Biology,** Feb. 2009.
B. Atakan, O. B. Akan, "On Molecular Multiple-Access, Broadcast, and Relay Channels in Nanonetworks" **ACM/ICST BIONETICS 2008**, Hyogo, Japan, 2008.
B. Atakan, O. B. Akan, "Single and Multiple Access Channel Capacity in Molecular Nanonetworks", **ICST/ACM NANO-NET 2009**, December 2009.
M. Pierobon, I. F. Akyildiz, "A Physical Channel Model for Molecular Communication in Nanonetworks," **IEEE JSAC**, vol. 28, pp. 602-611, 2010.

Mobile Ad Hoc Molecular Nanonetworks (MAMNET)



$$R_c \approx \frac{4\pi r^2 E[\upsilon_{nn}]}{V}$$

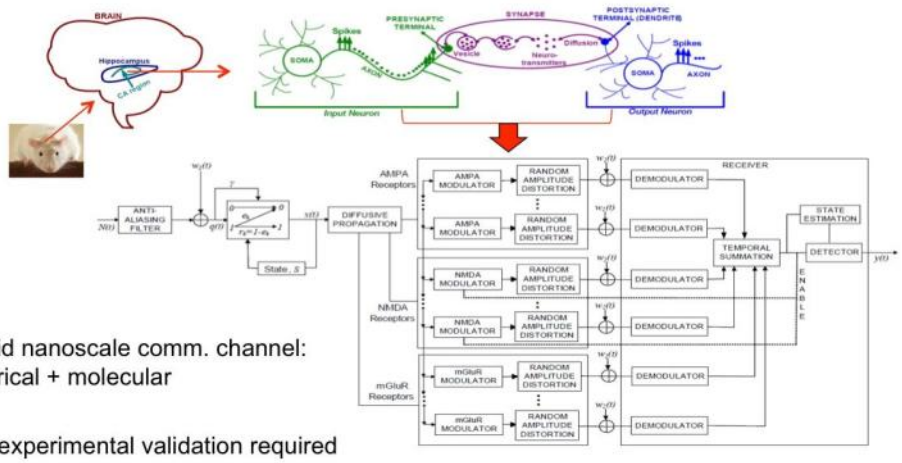
$$R_a = 1 - \sum_{i=0}^{c-1} p_i(\tau_c)$$

$$R_t = (1 - P_E)^n$$

Could be used for intra-body surveillance (inspired by how immune system works)

A. Guney, B. Atakan, O. B. Akan, "Mobile Ad Hoc Nanonetworks with Collision-based Molecular Communication," to appear in **IEEE Transactions on Mobile Computing**, 2011.

Nanoscale Neuro-spike Communication

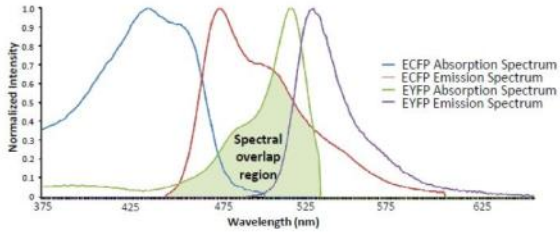


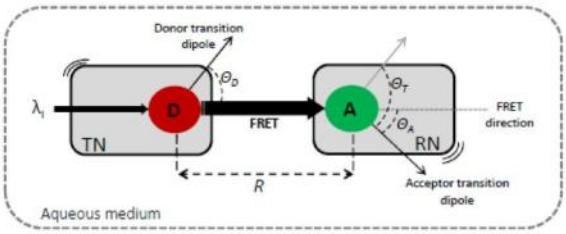
- Hybrid nanoscale comm. channel: electrical + molecular
- E2E experimental validation required

Can we learn from the ultimate integrated surveillance system, i.e., human body?

E. Balevi, O. B. Akan, "A Physical Channel Model and Analysis of Nanoscale Neuro-spike Communication," submitted to **IEEE Transactions on Communications**, Dec. 2010.
E. Balevi, O. B. Akan, "Synaptic Gaussian Multiple Access Channel," submitted to **IEEE Communications Letters**, Feb. 2011.

Förster Resonance Energy Transfer (FRET)-based Nanoscale Molecular Communication



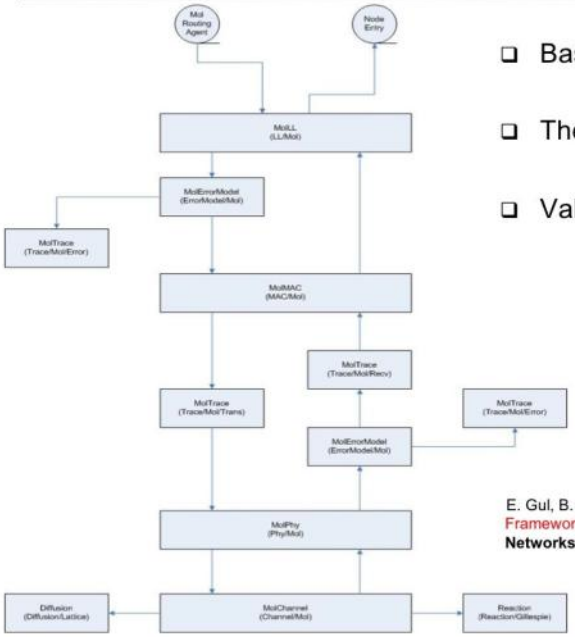


- Non-radiative energy transfer
- Excitation of D → Bit 1
  No-excitation → Bit 0

Could be used as part of an online and remote DNA testing system

M. Kuscu, O. B. Akan, "A Nanoscale Communication Channel with Fluorescence Resonance Energy Transfer (FRET)", in **Proc. IEEE MoNaCom 2011** (in conjunction with **IEEE INFOCOM 2011**), Shanghai, China, April 2011.

NanoNS: Molecular Nanonetwork Simulator



- Based on open source *ns-2*
- The first nano communication simulator
- Validated with theoretical results

E. Gul, B. Atakan, O. B. Akan, "NanoNS: A Nanoscale Network Simulator Framework for Molecular Communications," **Nano Communication Networks Journal (Elsevier)**, vol. 1, no. 2, pp. 138-156, 2010.

Open Issues and Possible Research Directions

- *Cognitive wired/optical/wireless communications for pervasive surveillance*
- *Broadband wireless passive communications (backup?) for video surveillance*
- *THz communication techniques for nanonetwork-enabled surveillance*
- *New communication techniques for surveillance nanosensor networks*
- *Digital surveillance & participatory surveillance with the existing mobile comm infr.*
- *Surveillance-aware jointly-optimization of signal capture and communication…*
- *Fundamental limits of information theoretical surveillance capability*

We can theoretically model, analyze, design and develop real-time and practical communication techniques and systems for surveillance solutions!!!

NWCL Crew, Collaborators, and Sponsors

Director:

Assoc. Prof. Özgür Barış Akan
Next-generation and Wireless Communications Laboratory
Department of Electrical and Electronics Engineering
Koc University
http://home.ku.edu.tr/~akan
akan@ku.edu.tr

Crew:

(Some) Sponsors:

IBM, TÜBA, TÜBİTAK, aselsan, KOÇ UNIVERSITY

(Some) Partners:

Georgia Tech, UPC, Ohio State University, University of Nebraska Lincoln, KTH, Trinity College Dublin, Bergische Universität Wuppertal

Session 3: Privacy

Towards privacy-enabled tracking and people re-identification in multi-Camera systems

Eduardo MONARI
FRAUNHOFER IOSB, DE

Towards People Re-Identification in Multi-Camera Video Surveillance Systems

„A Critical View“

Fraunhofer

Fraunhofer Institute of Optronics, System Technologies and Image Exploitation

Eduardo Monari

Ispra, 2011-07-05

Fraunhofer

The Profile of the Fraunhofer-Gesellschaft

- 60 Institutes
- 18 000 employees
- 1.65 billion €
  Budet (2010)

7 Groups:

- Information and Communication Technology
- Life Sciences
- Microelectronics
- Light & Surfaces
- Production
- Materials and Components - MATERIALS
- Defense and Security

Fraunhofer

Fraunhofer IOSB

Director Site Karlsruhe
Prof. Dr.-Ing.
Jürgen Beyerer
(executive)

Director Site Ettlingen
Prof. Dr.
Maurus Tacke

Operational Costs in 2011	37,5 Mio €
Permanent employees	375
of which scientists and eng.	282
Additional student aides	130

Lemgo

Ilmenau

Beijing

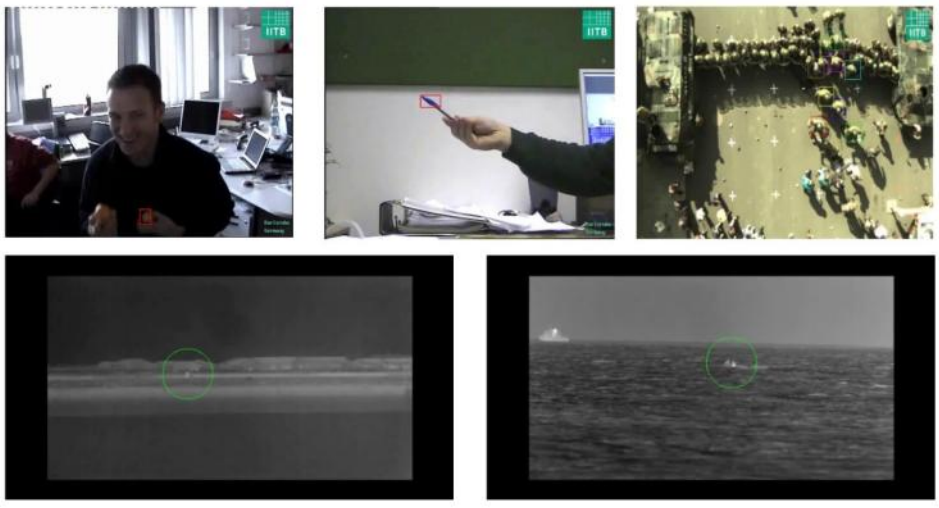
The IOSB is connected to Karlsruhe Institute of Technologie KIT
Department of Computer Sciences,
Institute for Anthropomatics, Vision and Fusion Laboratory

Fraunhofer

Video Surveillance Research at the IOSB

Fraunhofer

Video Surveillance Research at the IOSB



Fraunhofer

… But Not Only Security Applications…

tropS-System / Fraunhofer IOSB

The Challange:
2 HD-Cameras, 1 PTZ (optional), 2 PCs, approx. 60 Min. Setup-Time,
Real-Time Processing, 5000€/system maximum!
Full operational system in 1 year…

Fraunhofer

Towards People Re-Identification in Multi-Camera Video Surveillance Systems

A Critical View

Fraunhofer

Motivation for Multi Camera Tracking

person monitoring

vehicle monitoring

anti-theft protection/
abandoned luggage detection

Fraunhofer

The Challange

- Multi-Camera-Tracking = People Re-Identification

Why?

- Non-overlapping and distributed field of views
- Object occlusions due to barriers in FoV
- Object occlusions due to crowds
- People are just not visible all the time!

Fraunhofer

Single Target Multi Camera Tracking / NEST-System

NEST-System / Fraunhofer IOSB

Fraunhofer

How human operators re-identify people…

- Appearence Features
  - Geometric features (e.g. Shape, Height, etc.)
  - Colors / Texture of clothes
- Soft-biometrics and Biometrics
  - Ethnics
  - Age
  - Gender
  - Face

Who is Who?

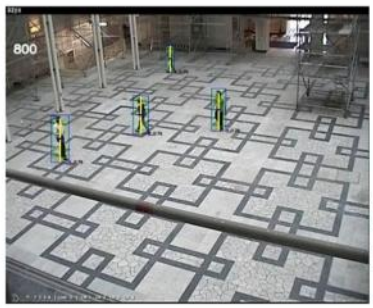
Fraunhofer

APPEARANCE FEATURES FOR PEOPLE RE-IDENTIFICATION

Fraunhofer

Appearance Features for People Re-Identification

- Appearence Features
  - Geometric features (e.g. Height) → Camera calibration? Highly accurate segmentation? Full body reconstruction?
  - Colors / texture of clothes

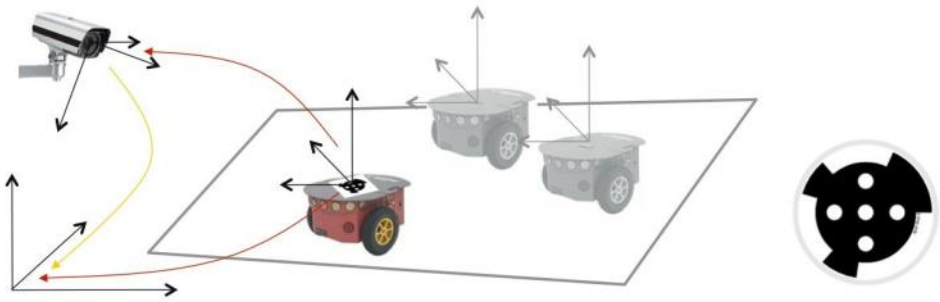


Fraunhofer IOSB

Fraunhofer

Work in Progress on Calibration at the IOSB

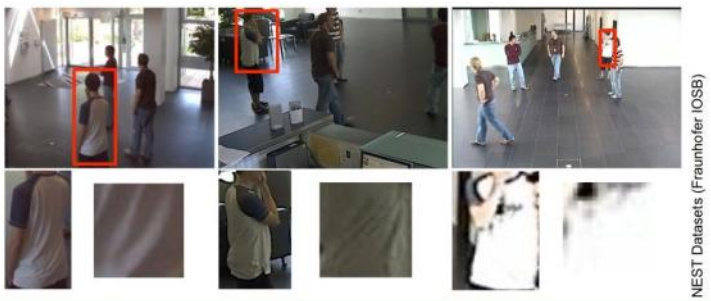
- Self-funded Research Project (started in 2011):
  - Semi-automated extrinsic camera calibration (Indoor-Robot-based)



Fraunhofer

Appearance Features for People Re-Identification

- Appearence Features
  - Geometric features (e.g. Height)
  - Colors / texture of clothes → Color constancy? View point invariance?

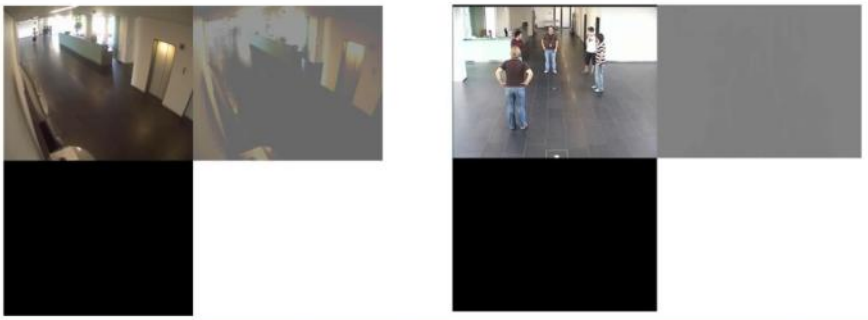


NEST Datasets (Fraunhofer IOSB)

Fraunhofer

Appearance Features for People Re-Identification

- Appearence Features
  - Geometric features (e.g. Height)
  - Colors / texture of clothes → Color constancy? View point invariance?



Fraunhofer IOSB

Fraunhofer

Appearance Features for People Re-Identification

- Open issues:
  - **Simple and fast calibration methods** (geometric calibration and color normalization)
  - Estimation of **local illumination conditions**
  - Robust algorithms and approaches for **self-calibration**
  - **Standards for color descriptors (meta data formats)**
- Future Applications:
  - Interoperability in **video archive search** (using normalized color descriptions and standard coordinate systems)
  - Interactive **avatar-based database queries** (due to normalized colors)

Fraunhofer

Limitations of Appearance Features

Fraunhofer

(SOFT-)BIOMETRICS FOR PEOPLE RE-IDENTIFICATION

Fraunhofer

(Soft-)Biometrics for People Re-Identification

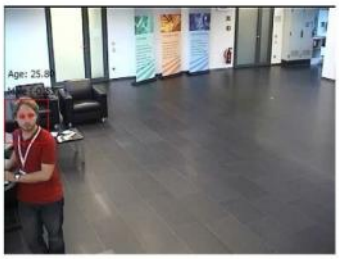
- Soft-biometrics and biometrics
  - Ethnics
  - Age
  - Gender
  - Face
  - Etc.

Fraunhofer

(Soft-)Biometrics for People Re-Identification

- Soft-biometrics and biometrics
  - Ethnics
  - Age
  - Gender
  - Face

→ Most approaches are based on classification of faces.



Fraunhofer IOSB

KIT, CVHCI Group (Prof. Stiefelhagen)

Fraunhofer

(Soft-)Biometrics for People Re-Identification

- Soft-biometrics and biometrics
  - Ethnics
  - Age
  - Gender
  - Face

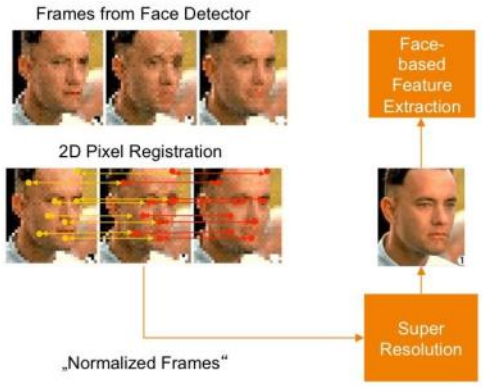
→ Problem: Head pose invariance, low resolution/large distance in video surveillance, illumination conditions

Fraunhofer IOSB

Fraunhofer

Extraction of Face-based Biometrics at a Distance

- 2D-superresolution for non-rigid objects (faces)



Images : http://gravis.cs.unibas.ch/Sigg99.html

Fraunhofer

Extraction of Face-based Biometrics at a Distance

Fraunhofer

HD-Cameras

- Why not taking cameras with higher resolution?
  - The main challanges remain the same
    - illumination conditions
    - limited computational power
    - complex non-cooperative situations to handle
  - and if HD allows for person re-identification at 100m, the customer would like to re-identify them at 150m… ;-)

Fraunhofer

(Soft-)Biometrics for People Re-Identification

- Open issues regarding (soft-)biometrics:
  - **Robust face detection and head pose estimation** (head pose and illumination invariance, motion blurring)
  - **Robust** approaches für **resolution enhancement**
  - **Evaluation Datasets*** (for face-based soft-biometrics in video surveillance scenarios)

NEST Datasets (Fraunhofer IOSB)

* iLIDS/PETS?

Fraunhofer

(SOFT-)BIOMETRICS AND PRIVACY ASPECTS

Fraunhofer

(Soft-)Biometrics and Privacy Aspects

- Appearence Features
  - Geometric features (e.g. Height)
  - Colors / Texture of clothes
- Soft-biometrics and biometrics
  - Ethnics
  - Age
  - Gender
  - Face

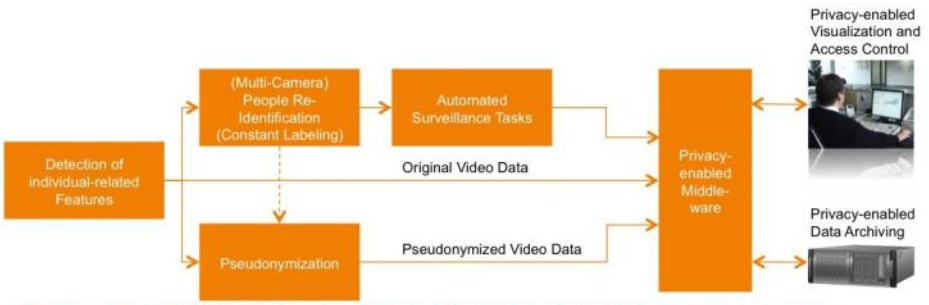
Level of Detail

The **more features** we can extract, the more important the **privacy aspects**!

Fraunhofer

(Soft-)Biometrics and Privacy Aspects

- Robust feature detectors are needed to find privacy-sensitive contents.
- If we are able to detect individual-related features, we are also able to perform pseudonymization.



- **Talk of Prof. Gong: Dynamic recognition of distinctive features!**

Fraunhofer

Possible Directions / Our Roadmap

- Research and development on two areas in parallel is needed
  - OVERALL TOPIC: **Detection and extraction of privacy-sensitive content in images/videos**

Fraunhofer

Possible Directions / Our Roadmap

- Research and development on two areas in parallel is needed
  - OVERALL TOPIC: **Detection and extraction of privacy-sensitive content in images/videos**
    - SUB-TOPIC 1: **People re-Identification in distributed camera networks**
      - … to solve **geometric and color self-calibration** as well as the consistent labeling problems …
    - SUB-TOPIC 2: **Privacy-enabled system design** (pseudonymization of video data, privacy-awared data management)
      - … for privacy-awared visualization, video archiving and search.
  - **Talk of Andrea: Thinking about reliable distributed system and storage architectures (data security)!**

Fraunhofer

Possible Directions / Our Roadmap

- Why is privacy an important future topic?
  - **Acceptance** of video surveillance by the public
  - New upcoming „privacy sensitive“ applications für video systems
    - **ambient assisted living**
    - video-surveillance **in the cloud**
  - Future **legislation** of data handling
    (**advantage in competition** for privacy-enabled cameras and systems)

Fraunhofer

THANK YOU FOR YOUR ATTENTION!

Fraunhofer

Publikationen

- E. Monari, C. Pasqual. Fusion of Background Estimation Approaches for Motion Detection in Non-Static Backgrounds, 4th IEEE International Conference on Advanced Video and Signal based Surveillance (AVSS), London, UK. 2007.
- E. Monari, S. Voth, K. Kroschel. An Object- and Task-Oriented Architecture for Automated Video Surveillance in Distributed Sensor Network. 5th IEEE International Conference on Advanced Video and Signal Based Surveillance (AVSS). Santa Fe, New Mexico, USA. 2008.
- J. Moßgraber, E. Monari, F. Reinert, S. Eckel, A. Bauer, T. Emter, A. Laubenheimer. N.E.S.T. – Network Enabled Surveillance and Tracking. Future Security - 3rd Security Research Conference Karlsruhe, Germany. 2008.
- E. Monari, J. Maerker, K. Kroschel. A Robust and Efficient Approach for Human Tracking in Multi-Camera Systems. 6th IEEE International Conference on Advanced Video and Signal Based Surveillance (AVSS). Genova, Italy. 2009.
- E. Monari, K. Kroschel. A Knowledge-based Camera Selection Approach for Object Tracking in Large Sensor Networks. – 3rd ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC). Como, Italy. 2009.
- E. Monari. Auftragsorientierte Videoauswertung zur sensorübergreifenden Objektverfolgung in große verteilte Kamerasysteme. VDI/VDE GMA Expertenforum „Verteilte Messsysteme“. Braunschweig. 2010.

Fraunhofer

Publikationen

- E. Monari, K. Kroschel. Ein auftragsorientierter Ansatz zur kameraübergreifenden Personenverfolgung in verteilten Kameranetzwerken. tm – Technisches Messen, Oldenburg Wissenschaftsverlag, Jahrgang 77 (2010), Heft 10, S. 530-537, 2010.
- E. Monari, K. Kroschel. Task-Oriented Object Tracking in Large Distributed Camera Networks. Proc. of the 2nd Workshop on Activity Monitoring by Multi-Camera Surveillance Systems (AMMCSS), Boston, MA, USA, 29. Aug. 2010.
- E. Monari, K. Kroschel. Dynamic Sensor Selection for Single Target Tracking in Large Video Surveillance Networks. 7th IEEE International Conference on Advanced Video and Signal Based Surveillance (AVSS), Boston, MA, USA, 29. Aug.-1 Sept. 2010.

Fraunhofer

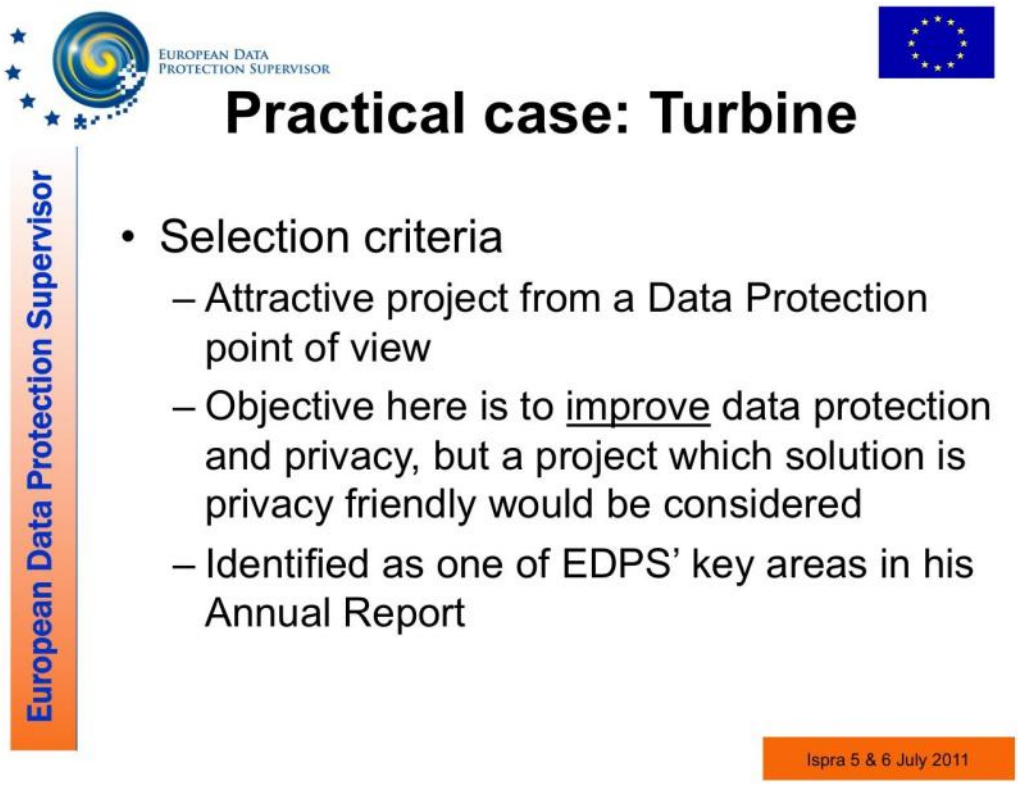
Privacy-by-design and surveillance technologies: challenges and opportunities

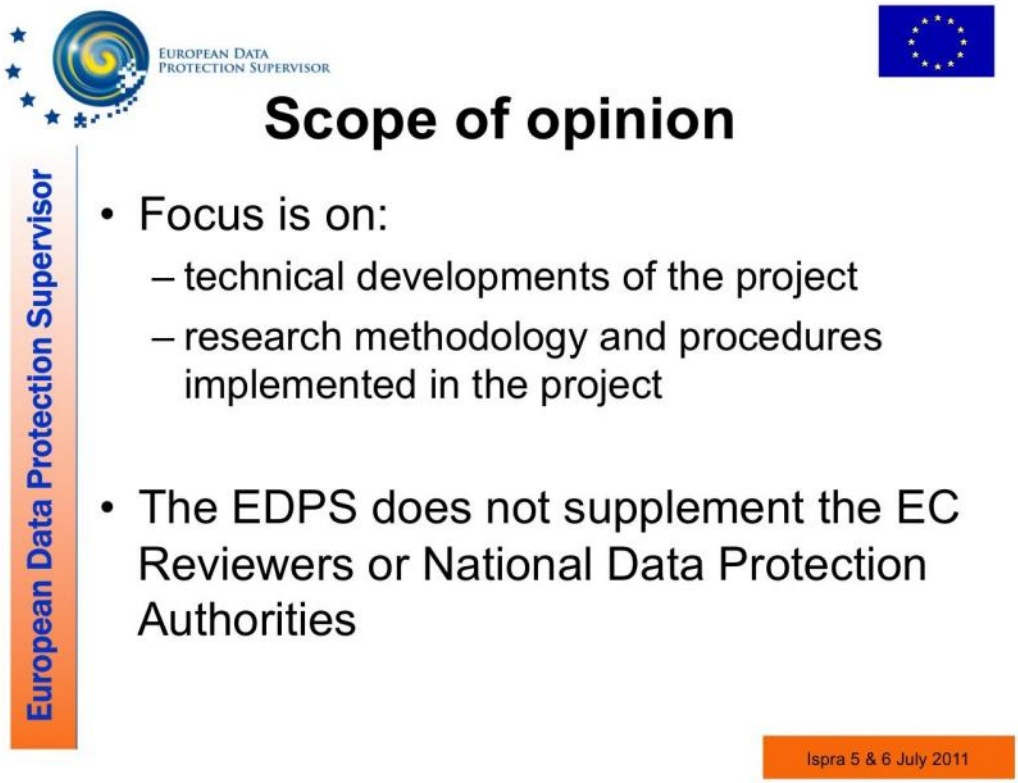
Laurent BESLAY
EDPS, EU

Privacy by design and surveillance technologies: challenges and opportunities


EUROPEAN DATA PROTECTION SUPERVISOR
Roles of EDPS
•Article 16 of the Lisbon Treaty & Regulation (EC) 45/2001
•Supervision
– Prior checks on biometrics
– Inspections and audits (Eurodac, VIS)
•Consultation
– Opinions on VIS, SIS II, EU passport, etc
– Evaluation of FP7 research projects
•Cooperation
– Opinions of Article 29 Working Party
– Coordinated supervision
European Data Protection Supervisor
Ispra 5 & 6 July 2011


EUROPEAN DATA PROTECTION SUPERVISOR
Interactions with targeted research projects
The EDPS facilitates discussion with National Data Protection Authorities
The EDPS selects/is made aware of projects which present specific DP issues and discusses about it with the EC
A consortium of a project can request an opinion from the EDPS.
European Data Protection Supervisor
Ispra 5 & 6 July 2011

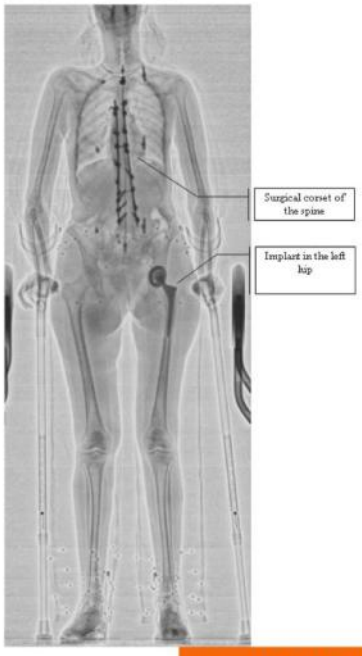

European Data Protection Supervisor
Practical case: Turbine
European Data Protection Supervisor
• Selection criteria
– Attractive project from a Data Protection point of view
– Objective here is to improve data protection and privacy, but a project which solution is privacy friendly would be considered
– Identified as one of EDPS' key areas in his Annual Report
Ispra 5 & 6 July 2011


European Data Protection Supervisor
Scope of opinion
European Data Protection Supervisor
• Focus is on:
– technical developments of the project
– research methodology and procedures implemented in the project
• The EDPS does not supplement the EC Reviewers or National Data Protection Authorities
Ispra 5 & 6 July 2011

EUROPEAN DATA PROTECTION SUPERVISOR

European Data Protection Supervisor

Body scanner

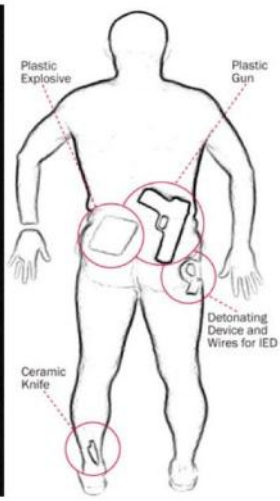


Ispra 5 & 6 July 2011

EUROPEAN DATA PROTECTION SUPERVISOR

European Data Protection Supervisor

And with privacy by design:



+ procedural safeguards

Ispra 5 & 6 July 2011

EUROPEAN DATA PROTECTION SUPERVISOR

European Data Protection Supervisor

"when the home network is connected to the Internet, the domain under consideration is no longer the home"

Carl Ellison, 2002, chief senior security architect, Microsoft

Personal space (understand privacy) is usually translated into physical distance from others

This private territory or privacy can be considered as a dynamic boundary regulation process

Edward T. Hall, The Hidden Dimension (1966).

Ispra 5 & 6 July 2011

EUROPEAN DATA PROTECTION SUPERVISOR

European Data Protection Supervisor

Internet of Things and a crime scene

Ispra 5 & 6 July 2011


European Data Protection Supervisor
Some possible tools...
European Data Protection Supervisor
→ Privacy by design principle
(obligation for the designer...)
→ Best Available Techniques
(inspired from EPPC Directive)
→ Privacy Impact Assessment
(RFID recommendation, co-regulation)
→ Privacy seals
(RFID recommendation, co-regulation)
→ Data breach notification
(new directive 2002/58 and forthcoming revision of general privacy Directive 1995/46)
Ispra 5 & 6 July 2011


European Data Protection Supervisor
European Data Protection Supervisor
?
Ispra 5 & 6 July 2011

Managing privacy in emerging video surveillance systems

Fanny COUDERT
ICRI-KUL, BE

KATHOLIEKE UNIVERSITEIT LEUVEN

Managing privacy in emerging videosurveillance systems

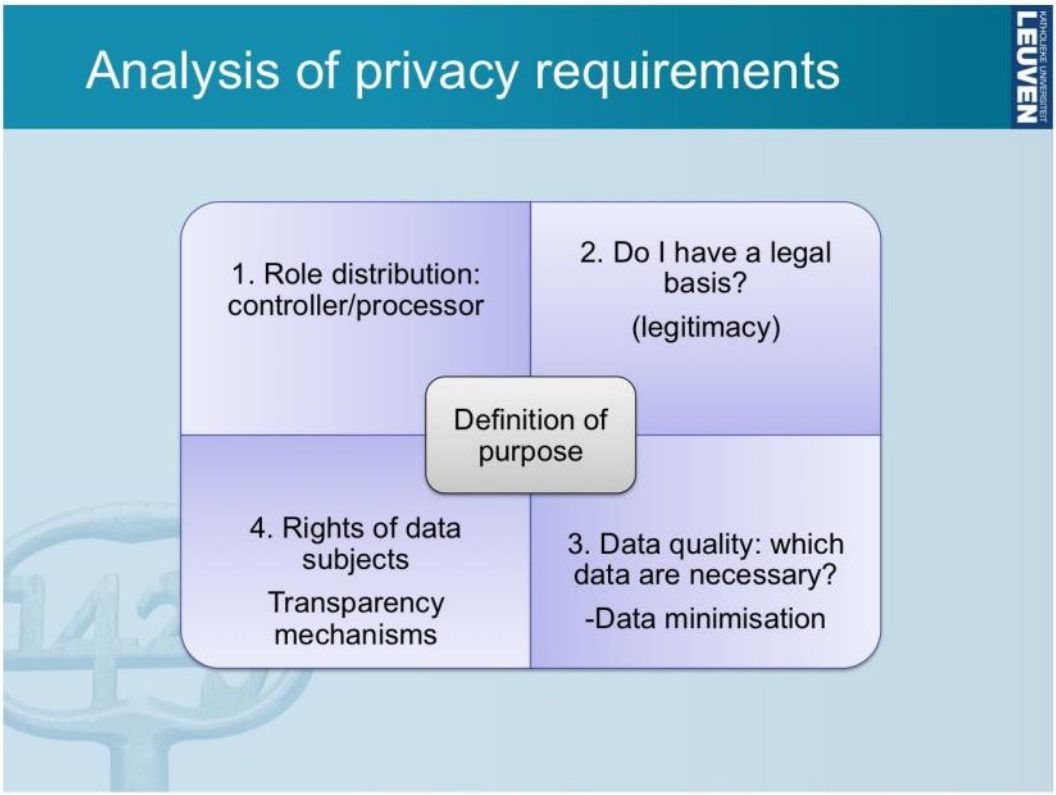
Workshop on Emerging surveillance capabilities & requirements, JRC IPSC, 5 July 2011

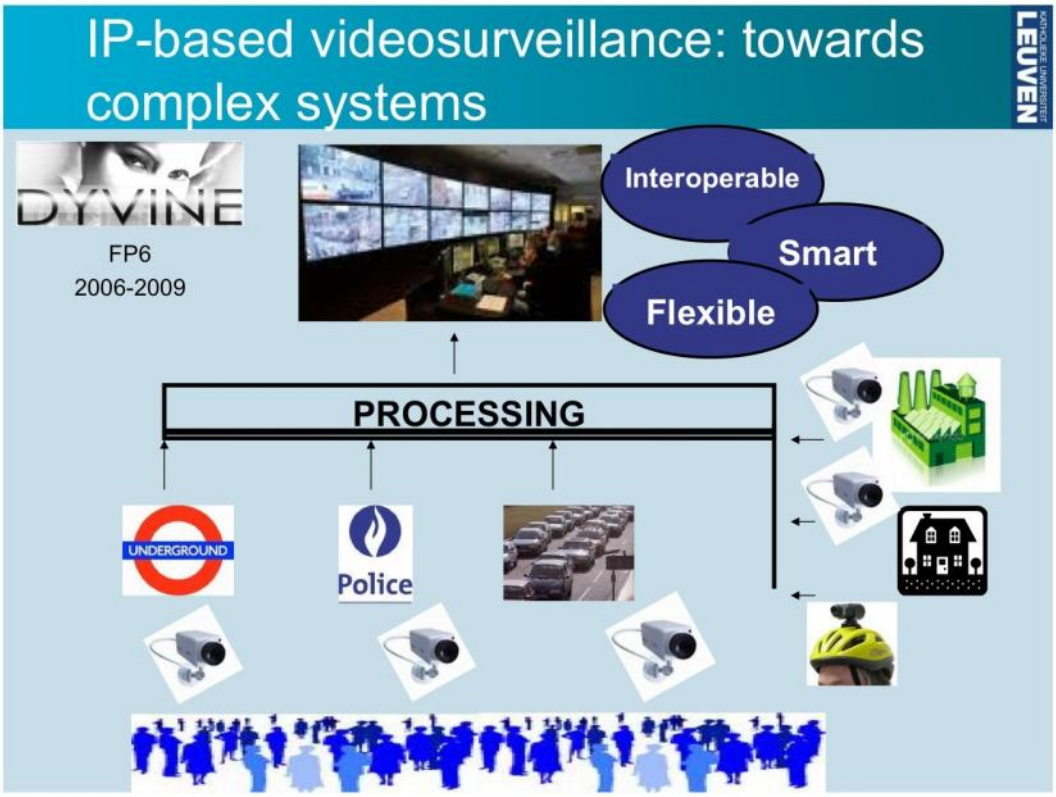
Fanny Coudert
Interdisciplinary Centre for Law and ICT (ICRI) - K.U. Leuven – IBBT

Agenda

- Emerging video surveillance systems: privacy challenges
- Managing privacy in complex IT environments:
  - ❑ Privacy as a risk
  - ❑ Privacy Impact Assessments


1425
Privacy challenges in emerging video surveillance systems


Analysis of privacy requirements
LEUVEN
1. Role distribution: controller/processor
2. Do I have a legal basis?
(legitimacy)
Definition of purpose
4. Rights of data subjects
Transparency mechanisms
3. Data quality: which data are necessary?
-Data minimisation


IP-based videosurveillance: towards complex systems
LEUVEN
DYVINE
FP6
2006-2009
Interoperable
Smart
Flexible
PROCESSING
UNDERGROUND
Police


1425
Managing privacy in complex video surveillance systems: Privacy Impact Assessments (PIA)

Privacy impact assessment

- A PIA is a process whereby a **conscious** and **systematic** effort is made to assess the **privacy** and data protection **impacts** of a specific system or application with the **view of taking appropriate actions** to prevent or at least minimise those impacts. (*RFID PIA framework)*

→ *Based on a privacy risk management approach*
→ *»Data governance tool »*

Rationale for data protection

Data protection laws as instruments to channel power
(De Hert&Gutwirth)

Limit the interference of new technologies into citizens' **fundamental rights**

Not only privacy!
Also e.g. freedom of movement

Privacy as a risk

→ Manage privacy as a risk to foster public acceptance of the system

What are privacy impact assessments?

- They go beyond a simple legal compliance check
- They are directed to policy choices: they include moral & ethical issues posed by the system
  - Ought we to do this?
  - Is there another, better way of doing this?
- PIAs are prospective:
  - Raise privacy alarms at an early stage in an organisation planning process
  - Mitigate risks as well as to modify plans accordingly
- PIAs are protean documents: it is a process rather than an outcome

PIA framework for RFID applications

- Objectives
  - Identify privacy risks caused by an RFID application
  - Document how these risks are pro-actively mitigated through technical and organisational meausres
- Methodology:
  - 1st phase: assess whether a PIA is needed and the scale of it
  - 2nd phase:
    - Describe the RFID Application (data flows, data structure, strategic environment)
    - Identify how this RFID application could threaten privacy and evaluate likelihood and magnitude of the risks *from a privacy perspective*
    - Document current and proposed technical (*privacy-by-design*) and organisational controls (*operational procedures, raising awareness*) to mitigate these risks
    - Document the result of the analysis (PIA report)

Conclusion

Suggestions for a better implementation of privacy safeguards

- *Change the way how privacy is approached*: not only as a legal requirement but also as a risk
- *Precautionary principle:* Change the burden of the proof for the harmlessness of a new technology (evidence-based policy)
- *Privacy Impact Assessments* as a tool to achieve these changes: develop an EU framework for video surveillance and other Security technologies?

References

- Loughborough University, Privacy Impact Assesments: international study of their application and effects, October 2007
- ICO, Privacy Impact Assessment Handbook, 2009
- Privacy and Data Protection Impact assessment framework for RFID applications, 12 January 2011
- Bennett C.J. & Raab C.D., *The governance of privacy*, MIT Press, 2006.


1425
Thank you for your attention!
fanny.coudert@law.kuleuven.be
ICRI- K.U.Leuven – IBBT
http://www.icri.be
icri
IBBT

Privacy Enforcement for Surveillance Systems

Hauke VAGTS
FRAUNHOFER IOSB, DE

JRC Workshop

Privacy Enforcement for Surveillance Systems

A new paradigm for data privacy

Hauke Vagts

Fraunhofer IOSB

Motivation

- Current Situation
  - About 4 Million cameras in the UK thereof 500,000 in London
  - Interconnection of surveillance networks
  - Multi-sensor surveillance networks
  - Unclear legal and social aspects

- **Smart surveillance solutions are required!**

> "Who can analyze this mess of data"
>
> Prof. Dr. Jutta Limbach, 2002

- **Smart surveillance requires new privacy and security solutions!**

> "A CCTV System can be set up by anyone, there is no need for a license, and the central government does not control the use to which it is put."
>
> Williams, 2000

Overview

- Challenges for Security and Privacy
- An Interdisciplinary Approach for Privacy
- Object-oriented World Model and NEST
- Fair Information Practices Principles
- A Framework for Privacy Enforcement
- Conclusion
- Outlook & Challenges

Fraunhofer KIT

Key Challenges in Smart Surveillance

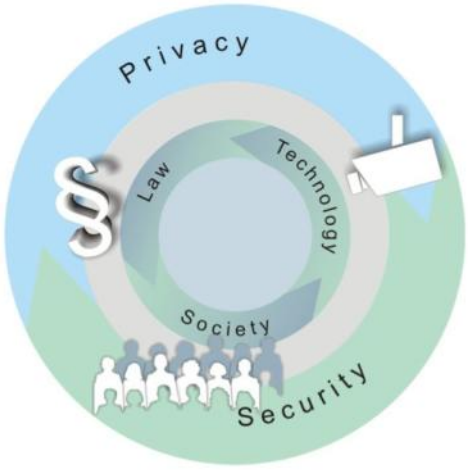
- Security Challenges
  - Secure architecture
  - Certification
  - Access controls and flow of information
  - Trust in a flexible and distributed system
- Privacy Challenges
  - Protection of privacy
  - Data exchange between multiple parties
  - Trust in surveillance and privacy

Fraunhofer KIT

An Interdisciplinary Approach

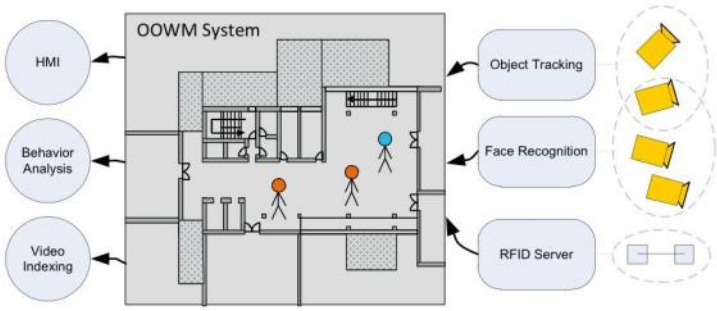
- Surveillance technology cannot be examined in isolation

- Law
  - Internationalization
  - Privacy Enhancing Technologies
- Society
  - User acceptance
  - Implication on society
- Technology
  - Brings it all together
  - Privacy by Design



Fraunhofer KIT

Object-oriented World Model (OOWM)



- NEST* architecture
  - SOA-based surveillance syste
  - Management by exception
  - Task-oriented approach
  - Plug and Protect

- OOWM
  - Bridges the gap between heterogeneous sensors and application-level software
  - Tasks:
    - Information representation and distribution
    - Data association
    - Data fusion and tracking
    - Information aging and management

* Network Enabled Surveillance Sy

Fraunhofer KIT

Fair Information Practices Principles (FIP)

- Heterogeneous law and not fully explored legal situation
- FIP were published by the OECD
- FIP are the minimum requirements

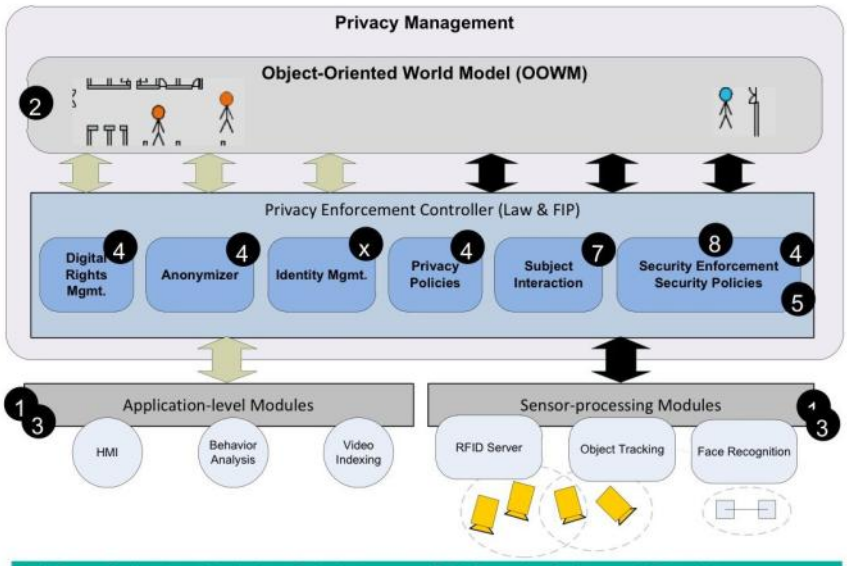
(P1) Data Collection Limitation Principle
(P2) Data Quality Principle
(P3) Purpose Specification
(P4) Use Limitation Principle
(P5) Security Safeguard Principle
(P6) Openness Principle
(P7) Individual Participation Principle
(P8) Accountability Principle

The Task-oriented Approach

- Efficient usage of resources
  - Sensors, memory, bandwidth,...
- The amount of data is reduced
- E.g., tracking of one person from a reception to a meeting room

- Advantages for privacy
  - The surveillance task is specified exactly
  - Data is collected only for a specific task
  - Only task-relevant services are granted access
  - Surveillance subjects can request information for each task
  - Privacy policies can be adapted according to the tasks

A Framework for Privacy Enforcement



(P1) Data Collection Limitation Principle	(P5) Security Safeguard Principle
(P2) Data Quality Principle	(P6) Openness Principle
(P3) Purpose Specification	(P7) Individual Participation Principle
(P4) Use Limitation Principle	(P8) Accountability Principle

Fraunhofer KIT

Hauke Vagts / 9

Anonymization

- How to measure privacy for Surveillance Systems?
- Take advantage of the abstract representation of the OOWM
  - Data is represented in tables
- Many metrics for privacy exist
  - Semantic of surveillance data is special, particularly position data is
  - L-diversity and k-Anonymity should be combined

- Algorithm for position data
  - Based on the approach from Bamba and Lui
    - Grid-based
    - → k objects must and l rooms bust be included in a response
  - Extended with aspects of the time
    - (latency, max. frequency, temporal variance)
  - Neither dummies nor path confusion

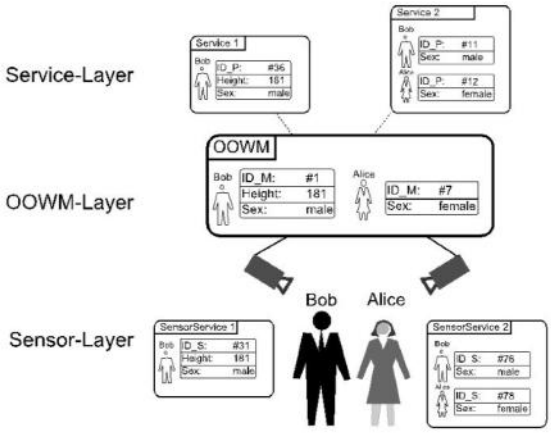
Fraunhofer KIT

Hauke Vagts / 10

Types of Identity Management

- Why do I need Identity Management (IdM)?
  - Three classes of IdM exist
    → Smart Surveillance is a new class of IdM

- Multi-Layer Identity Management



Social Aspects of Surveillance Systems

Objective: What are the factors for the acceptance of security technology?

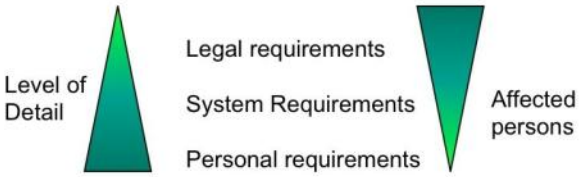
- Focus on Privacy Enhancing Technologies (PET) and technology for interaction
- Find and develop suitable technologies for all parts of the process chain
- Interdisciplinary discussion with sociologists, legal experts, political scientists and users

Collection → Processing → Storing → Visualization

Privacy Policies for Surveillance Systems

- Motivation:
  - Control the access to (sensitive) personal related data
  - Users should control their data
  - Achieve transparent data protection for the user

- Extension of XACML
- Hierarchies:
  - Policies can be grouped
  - The order represents the reality



- OptOut:
  - Polices are marked
  - Polices can be overwritten by the user

Hierarchies can be used and users can interact with the

Social Aspects

- Cultural differences
  - Surveillance is „a good Thing“ say 90% in London und 25% in Vienna
- Inhomogeneous sense of privacy
  - Personal level of privacy
  - Facebook vs. video surveillance
- Acceptance is not rational
  - Central station vs. a local park
- Users want control and transparency
  - Users need to feel privacy
  - Mobile devices?

Open Challenges for Privacy in Surveillance

- The following topics should addressed in the next calls:
- T1: "Useful" Anonymization
  - Video
  - Meta data
  - Altered material must be usable in court

- T2: Standardization

- T3: Usage Control of surveillance data
- T*n:* Further interdisciplinary research
  - Acceptance and social aspects
  - International law




Hauke Vagts / 17

Discussion

Thanks for your attention!

Contact Information:
Hauke Vagts

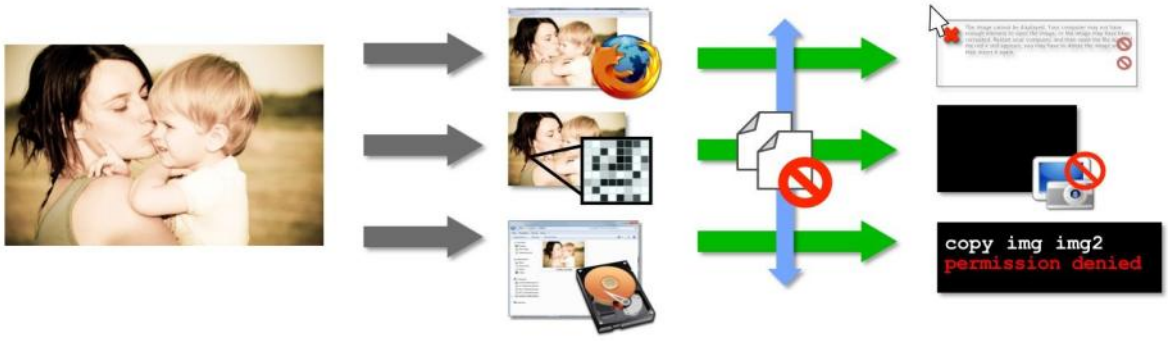
Fraunhofer IOSB
Fraunhoferstr. 1
D-76131 Karlsruhe

hauke.vagts@iosb.fraunhofer.de
+49-721-6091-574




Hauke Vagts / 18

Distributed Usage Control



A picture or frame	Exists in multiple representations	One rule for all layers	Can be applied individually

Objective;
Control the usage of data After access and distribution

Advantages:
Controlled distribution, transparency o f the usage, binding agreement

Can be used in :
Video surveillance, Ambient assistant living, Management of IP, eGovernment

Conclusion & Outlook

"Who can analyze this mess of data"
Prof. Dr. Jutta Limbach, 2002

"A CCTV System can be set up by anyone, there is no need for a license, and the central government does not control the use to which it is put."
Williams, 2000

- Conclusion
  - Privacy is a *key challenges* for modern surveillance
  - Smart surveillance can be more powerful and can be less intrusive at the same time
  - An OOWM and data abstraction offer new possibilities for privacy enforcement
  - An interdisciplinary approach is required for a future-proof solution
- Outlook
  - A lot of research must be done to enhance privacy und realize security
    - Topics in the next Security Theme
  - Approaches must be discussed with lawyers, sociologists and users/operators

Session 4: Requirements and Standards

Video-surveillance standardization and expected operational benefits

Jean Francois SULZER
THALES, FR

Video-surveillance Standardization

Expected Operational Benefits

Thales Security Solutions & Services jean-francois.sulzer@thalesgroup.com THALES

Video-surveillance today

- Video-surveillance has moved to digital video over IP
  - The components (cameras, actuators, servers,…) are subscribers to a network and communicate through RTP/RTSP protocols
  - Industry and integrators quickly found beneficial to mix components of different vendors
  - Technology largely derived from ICT with extensive use of XML
- Several standardization groups, but no full interoperability
  - Industry Forum ONVIF (led by AXIS, Bosch & Sony) and PSIA (established by CISCO) contribute to IEC/CENELEC TC79
  - Their primary objective is to be sure that new items are discovered and that all elements understand each other (no unique video format)
  - A method based on XML allows to share metadata, which remain largely system-specific
- This is of little help for police investigators that need to work on the files that they extract from commercial systems

3 /

Standardization for Societal security

- Video-surveillance is a crucial asset in intelligence collection, crime prevention, crisis management, forensic applications etc. The minimum requirement in societal security is for the authorities to be able to rapidly use the data collected by different CCTV systems from given locations.
- ISO/TC223 (Societal security) develops a standard specifying the exchange format and minimum technical requirements that ensure that the digital video-surveillance contents exported are compatible with the replay systems, establish an appropriate level of quality and contain all the context information (metadata) necessary for their processing .
- This standard in-progress (ISO22311) also contains provisions to ensure that citizen privacy measures can be implemented.
- This standard does not impose implementation methods or technological solutions. It relies heavily on individual technical standards separately developed (called as required) and concentrates on minimum necessary profiles or subsets thereof to achieve its societal security objectives.

JRC / 6 July 2011

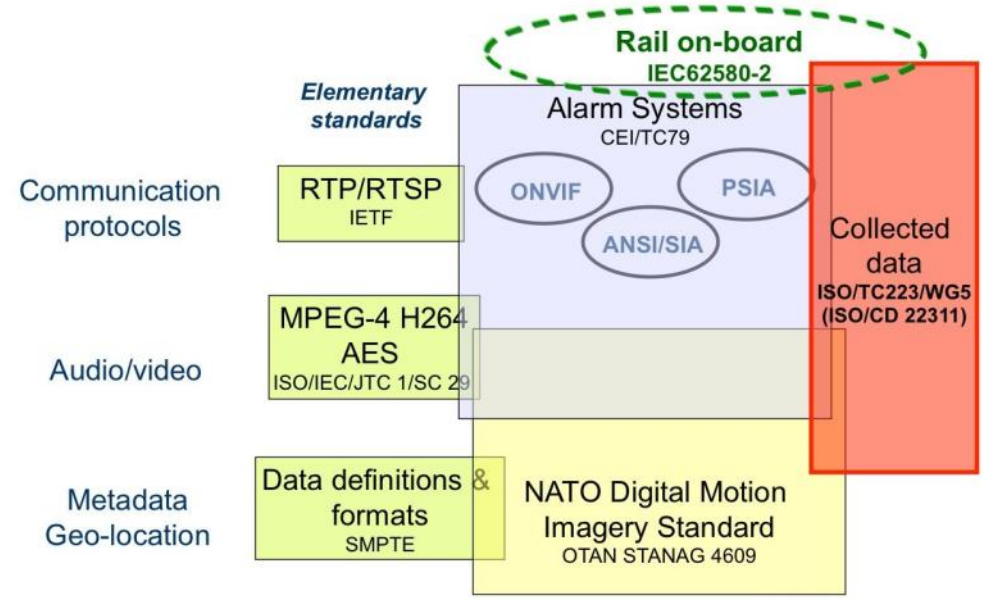
Thales Security Solutions & Services

3

THALES

4 /

Video standards environment



JRC / 6 July 2011

Thales Security Solutions & Services

THALES

5 /

Investigators Use case

Camera A (t=T0)

Frame showing victim when shot

PTZ moving to a new preset point

Camera B

Traffic camera

Camera C

Camera from a police station

Recorded at HQ after WiFi transmission

Camera D **Wide angle city fixed camera**

Based on their own reference, pictures for cameras B, C & D are those for the To frame
All camera systems are supposed to be compliant to ISO 22311 Level 2
Estimated speed of the taxi is 70 km/h (20 m/s) and of the blue bus is 35 km/h (10 m/s)
Two individuals of "Eagles" gang took a taxi (captured by camera C); four individuals supposed to be from the "Falcons" gang climbed aboard the blue bus (captured by camera B). There were gunshots and a passer-by (captured by camera A) was badly injured. The two individuals of the taxi can only be kept in custody for another 4 hours. Based on time provided by camera A and locations from camera D view, they are not involved. Is it true? Can this be challenged in court?

JRC / 6 July 2011

Thales Security Solutions & Services

THALES

6 /

Video-surveillance export (ISO 22311)

- **Video-surveillance export interoperability standard**
  - Initiated by a formal cooperation agreement between French security industries (GIFAS Security Commission) and Ministry of Interior
  - Vision rapidly endorsed as an ISO new project
  - Work is conducted within ISO/TC223/WG5 with French AFNOR secretariat (JF Sulzer convenor)
  - Active experts from Canada, China, France, Germany,Israel, Japan, Korea, South-Africa, UK and USA
  - For largest consensus, formal liaisons established and active with IEC TC97, the industry forums (ONVIF & PSIA) and NATO ST 4609
  - Objective is not to endorse an existing implementation, but to define a non-proprietary affordable solution for all future systems
- **ISO 22311 Edition 1 completion expected within one year**
  - Level 1 is minimal; it guarantees UTC time reference and enough descriptive metadata to understand structure of the exported file
  - Level 2 provides forensic oriented interoperability (standard geo-location scheme, synchronization and dynamic metadata, standard video format,…)

JRC / 6 July 2011

Thales Security Solutions & Services

6

THALES

7 /

Exchange Format Level 2

- Benefit from the fact that within systems, as per EN50132-5-1), data (contents and metadata) are streamed and synchronized using RTP/RTSP protocols
- Segment the information in time-slot files that can be associated without limit through a logical arborescence
- Export a set of such time-slot files with their their logical chaining through a classical "tar" (or equivalent) process
- Individual videos remain easily accessible to commercial players (like VLC), while massive transfers become possible without limitations
- Mechanism to synchronize dynamic metadata
- Few KLV encoded metadata mandated and usage of XML allowed (EN50132-5-1 §9.5.1 & 9.5.2)

JRC / 6 July 2011

Thales Security Solutions & Services

THALES

8 /

Exchange Format Level 2

- Benefit from the fact that within systems, as per EN50132-5-1), data (contents and metadata) are streamed and synchronized using RTP/RTSP protocols
- Segment the information in time-slot files that can be associated without limit through a logical arborescence
- Export a set of such time-slot files with their their logical chaining through a classical "tar" (or equivalent) process
- Individual videos remain easily accessible to commercial players (like VLC), while massive transfers become possible without limitations
- Mechanism to synchronize dynamic metadata
- Few KLV encoded metadata mandated and usage of XML allowed (EN50132-5-1 §9.5.1 & 9.5.2)

JRC / 6 July 2011

Thales Security Solutions & Services

THALES

9 /

ISO22311 Level 2

- **Key technical features**
  - H.264 compression and elementary streams for video
  - Synchronization data carrying capture (and current) time
  - Parallel logical structure identical for video audio or metadata, consistent with RTP/RTSP payloads
  - Organization in time slices for easy random access
  - Minimal set of metadata derived from the SMPTE scheme, allowing IEC62686-2 XML and providing KLV dynamic information

Typically MPEG-A as per ISO/IEC 23000 Part 10

JRC / 6 July 2011

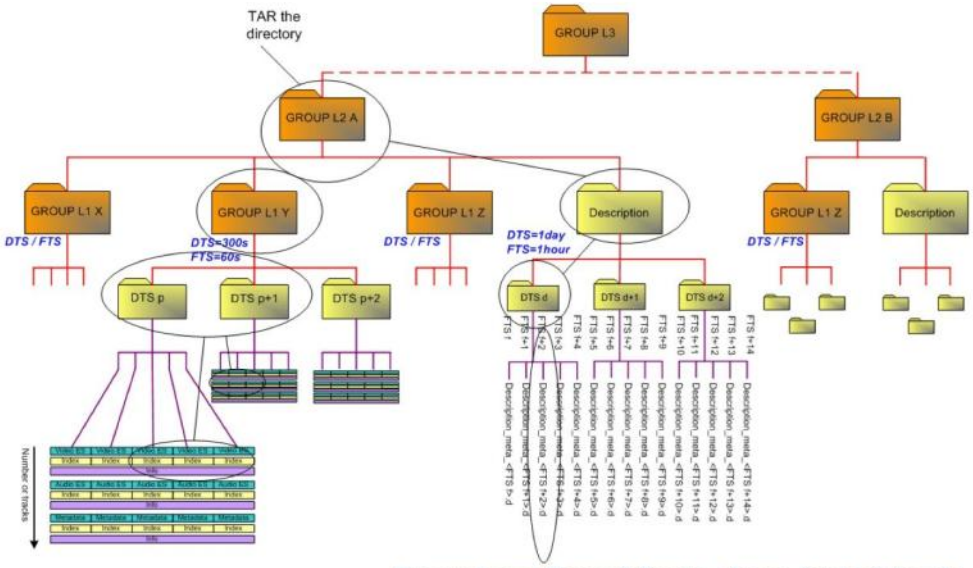
Thales Security Solutions & Services

9

THALES

10 /

Notional Export Process



Example => Export 6 min of one (video) track

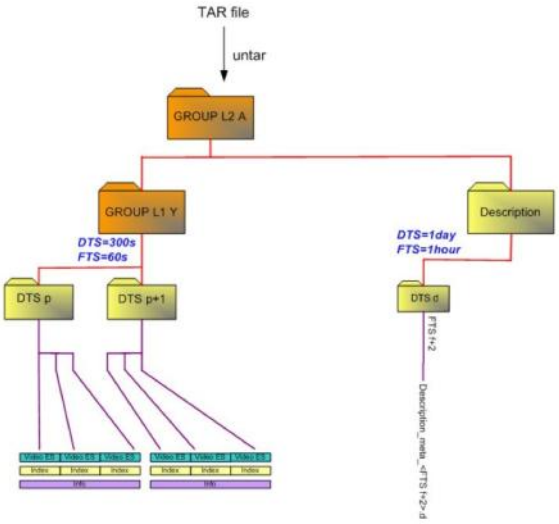
JRC / 6 July 2011

Thales Security Solutions & Services

THALES

11 /

Notional Exported File



- Export of 6 min of one (video) track
- Exported by tar (one or several merged tar)
- Result conserves the initial structure

JRC / 6 July 2011

Thales Security Solutions & Services

THALES

12 /

Benefit for Video Analytics

- All the "context" of the videos is automatically associated to the content
- There is a capture time stamp to which analytics results can be referred to
- A confidence factor can be associated to such results
- The four corners of each frame are geo-localized in an unambiguous and absolute manner
- This allows camera hand-over without boring calibration phases
- Original and created metadata can be managed consistently, allowing for data mining on all available data and for update of the indexes

JRC / 6 July 2011

Thales Security Solutions & Services

THALES

13 /

Way-forward

- By end of 2012 it is anticipated that all the quoted standards will be promulgated
- FP7 security projects under way will allow hands-on validation of their prescriptions
  - SECUR-ED for urban transportation
  - PROTECTRAIL for rail main lines
- It is anticipated that they will have validated
  - The forensics applications
  - The proper integration of video analytics
  - Some privacy measures
- It will then be possible to work on edition 2 of the standards and address new topics (like standard mapping for the constructions)

JRC / 6 July 2011

Thales Security Solutions & Services

THALES

14 /

You need a response?

JRC / 6 July 2011

For security solutions contact Thales

Thales Security Solutions & Services

THALES

A maturing industry depends on standards in engineering surveillance systems

Jeroen VAN REST
TNO, NL

A maturing surveillance industry depends on standards

Jeroen van Rest

TNO

TNO has 4300 employees in applied sciences, working for 7 domains:
- Defence, Safety & Security
- Transport & Mobility
- Built Environment
- Information Society
- Healthy Living
- Energy
- Industrial Innovation

TNO participates / coordinates, among others:
ADABTS, ARENA, VIRTUOSO, PROTECTRAIL, DEMAST, SECURED, and several proposals currently in negotiation

DARPA: Mind's Eye: detect 48 human behaviours (verbs) in video footage (TRL=4)

This presentation is built on work of many people and organisations

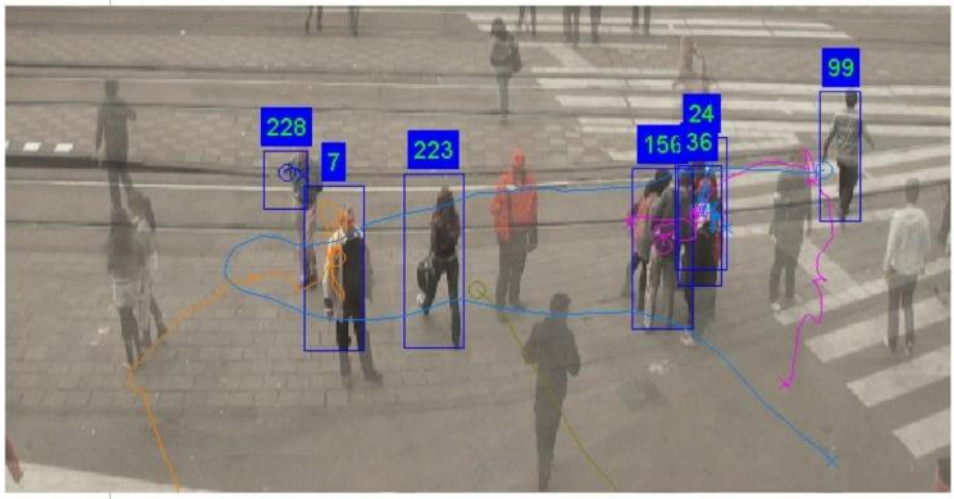
TNO innovation for life

Outline

- System Concepts for Surveillance
- Privacy by Design for Surveillance
- Test and Validation for Security Innovations

TNO innovation for life

Probing action



Deviant behaviour becomes suspicious behaviour

TNO innovation for life

Suspicious behaviour

Besides applying probing actions (a.k.a. Search Detect React)

Empirically:

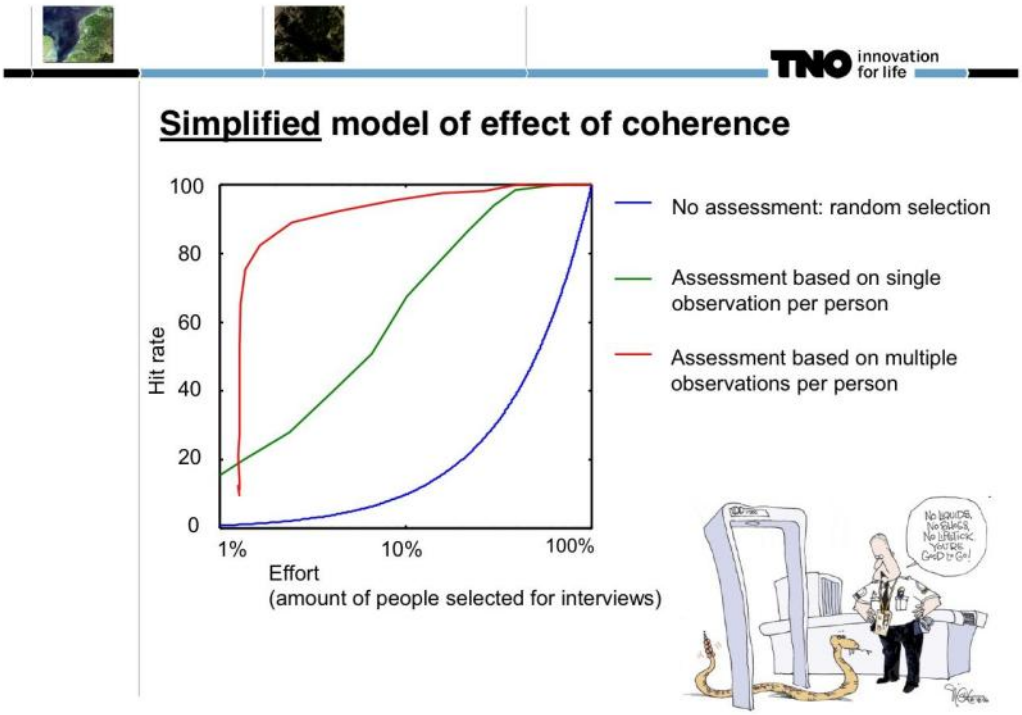
- Record human behaviour at location;
- Get list of actual security incidents;
- When no incident: normal behaviour;
- Find significant deviances in behaviour around security incidents;

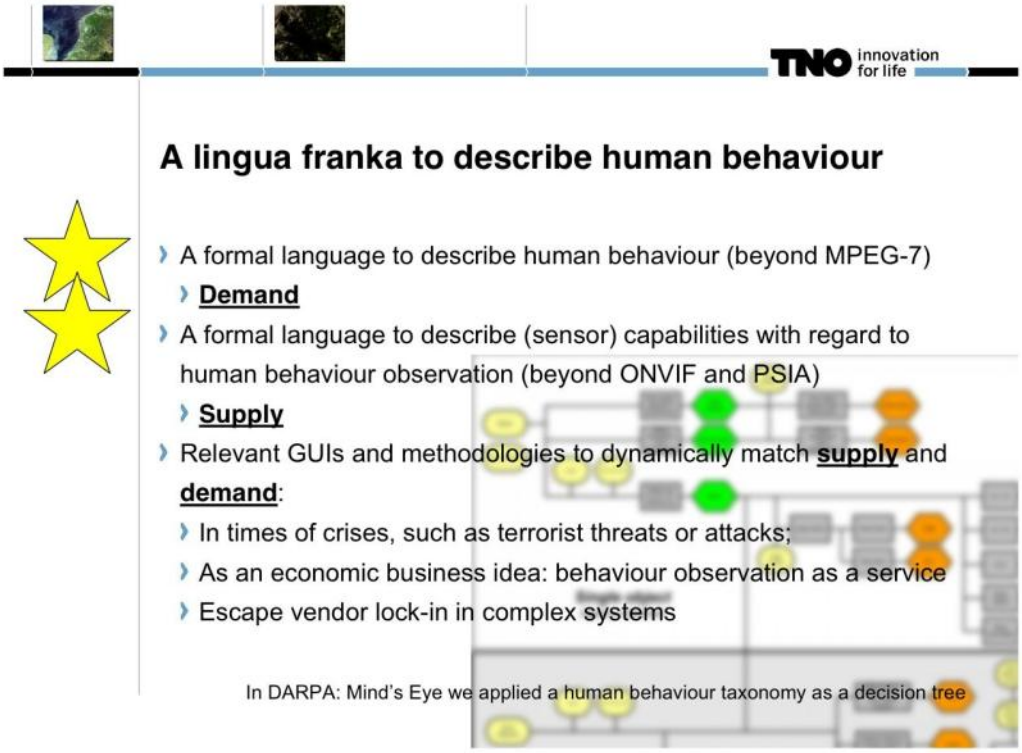
Implicitly: interview human surveillance operators

- Context: Mass transit: 196 explicit behaviours
  - Human interaction
  - Super-conformity
  - Large spatial area's and/or time frames

TNO innovation for life

Individual behaviour linked to social behaviour (groups, crowds)


TNO innovation for life
Simplified model of effect of coherence
100
80
60
40
20
0
Hit rate
1%
10%
100%
Effort
(amount of people selected for interviews)
No assessment: random selection
Assessment based on single observation per person
Assessment based on multiple observations per person


TNO innovation for life
A lingua franka to describe human behaviour
A formal language to describe human behaviour (beyond MPEG-7)
Demand
A formal language to describe (sensor) capabilities with regard to human behaviour observation (beyond ONVIF and PSIA)
Supply
Relevant GUIs and methodologies to dynamically match supply and demand:
In times of crises, such as terrorist threats or attacks;
As an economic business idea: behaviour observation as a service
Escape vendor lock-in in complex systems
In DARPA: Mind's Eye we applied a human behaviour taxonomy as a decision tree

TNO innovation for life

Language describing Human Behaviour

```
<HumanML>
  <person personid="id46437756">
    <intent>
        Suicideattack
    </intent>
    <movement Coordinate system="xyz">
        <walksto coord=23, 35>
        <walksto coord=23, 35>
        <walksto persoontype="police officer">
    </ movement >
  </person>
  <person type="police officer">
    <skills>
        SDR
    </skills>
    <intent>
        Secure trainstation
    </intent>
    < movement Coordinate system="xyz">
        <walksto coord=23, 35>
        <walksto coord=23, 35>
        <looksat persontype="passenger" personid="id46437756">
    </ movement >
  </person>
</HumanML>
```

TNO innovation for life

Tools and methodologies, definitions and strategies for privacy by design for surveillance technologies, including ICT systems – Capability Project

Topic SEC-2012 5.3-3 of EU Security call of 2011 July

Considerations

PbD: No one-size-fits-all solution
- We need toolbox, not the Ultimate Architecture™
- Focus on the process, not on the end result
- But we do need concrete examples

PbD: Should facilitate certification of [product, production process, design], but not enforce it
- Certification is up for debate, cannot be ruled in or out
- At best, certification can validate presence of PbD

PbD: Embrace both objective and subjective consequences
- Privacy is a matter of trust
- We need to relate to many domains: law, ethics, engineering, (ICT) governance, industry, society, policy-makers

Proposal Idea

1. Create common namespace for PbD over different domains
2. Collect & create metrics for subjective and objective consequences of PbD
3. Collect & create PbD-toolbox with: PIA, **Privacy Design Patterns**, PETs, Certification (EUROPRISE)
4. Map PbD-toolbox on design and **dynamic** usage processes (Waterfall, V-Model, Spiral Model, SIMILAR, TOGAF,)
5. Validate (use of) PbD-toolbox via design processes on Surveillance Technologies, using metrics
6. Meta evaluation: which drivers and barriers exist to apply PbD?

TNO innovation for life

Privacy-by-Design for Surveillance Systems:

Human Behaviour Observation Design Patterns

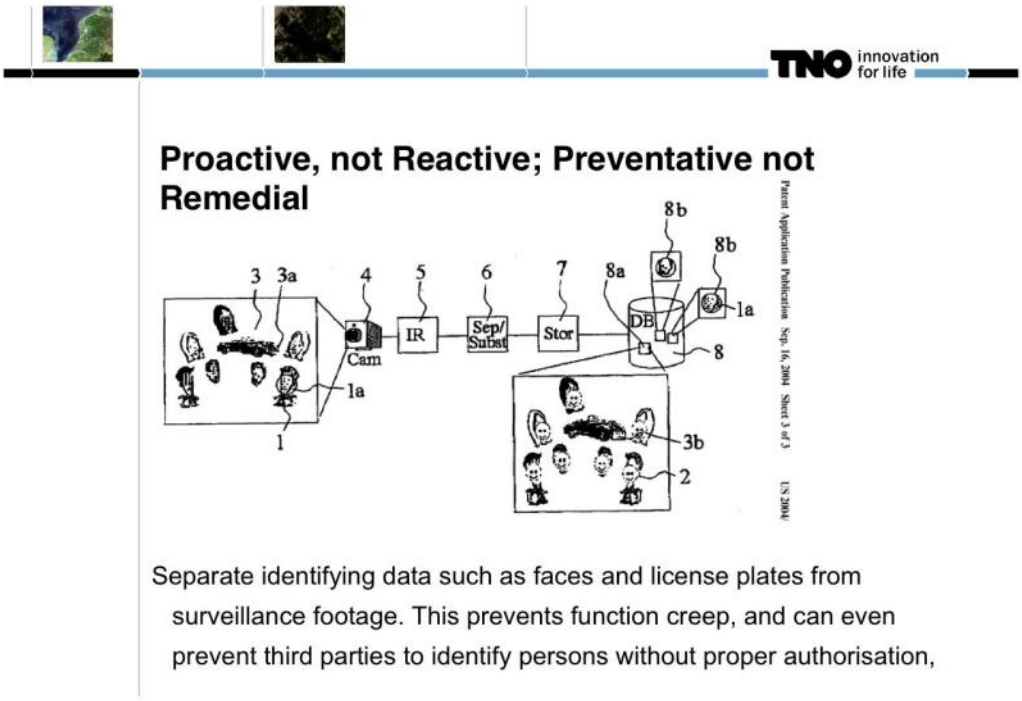
A person cannot control his identity, ethnicity or skin colour but with regard to behaviour, we do have a very strong sense of autonomy. We therefore have a responsibility about our voluntary behaviour.

Making data, information and knowledge about human behaviour available poses both risks and opportunities. By making such knowledge explicit, it also becomes controllable. Transparency, accountability, privacy and freedom of choice should be guiding principles.

TNO innovation for life

Proactive, not Reactive; Preventative not Remedial

- The Privacy by Design (PbD) approach is characterized by proactive rather than reactive measures. It anticipates and prevents privacy invasive events before they happen. PbD does not wait for privacy risks to materialize, nor does it offer remedies for resolving privacy infractions once they have occurred — it aims to prevent them from occurring. In short, Privacy by Design comes before-the-fact, not after.


TNO innovation for life
Proactive, not Reactive; Preventative not Remedial
3 3a 4 5 6 7 8a 8b 8b 1a
Cam
IR
Sep/ Subst
Stor
DB
1a
8
3b
2
1
Patent Application Publication Sep. 16, 2004 Sheet 3 of 3 US 2004
Separate identifying data such as faces and license plates from surveillance footage. This prevents function creep, and can even prevent third parties to identify persons without proper authorisation,


TNO innovation for life
Proactive, not Reactive; Preventative not Remedial
?
=
A second proactive design pattern would be to release long tracks of persons only when suspicious behaviour was observed on smaller sub-tracks. Large sets of observations on a person can then only be linked when subsets already show suspicious behaviour.
16
Wednesday, July 06, 2011

Privacy as the Default Setting

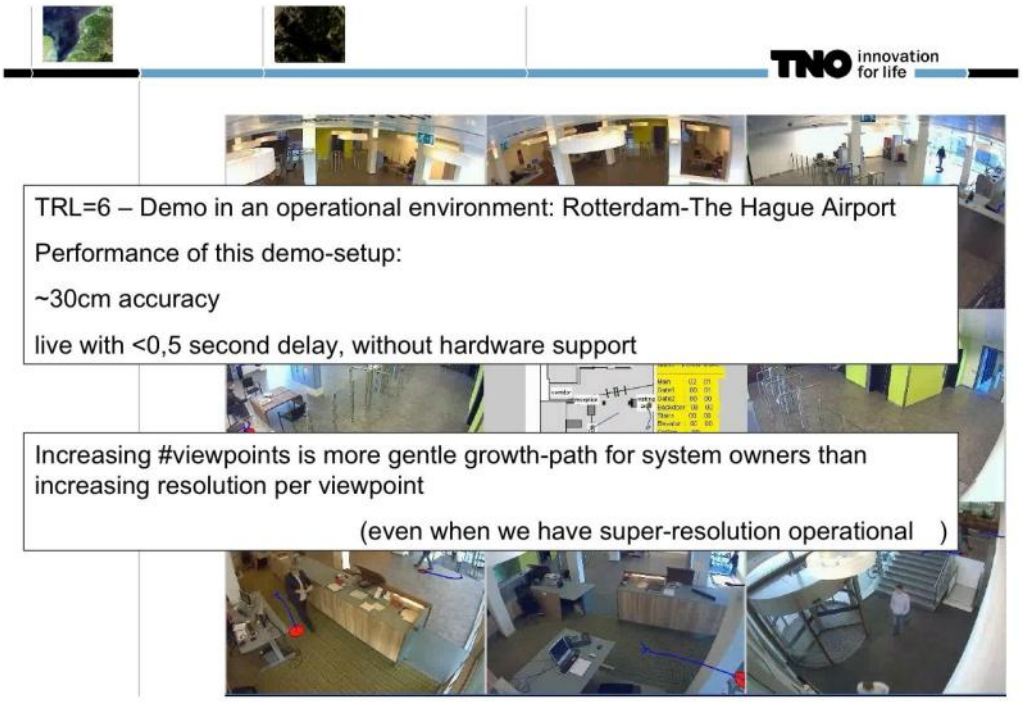
- We can all be certain of one thing — the default rules! Privacy by Design seeks to deliver the maximum degree of privacy by ensuring that personal data are automatically protected in any given IT system or business practice. If an individual does nothing, their privacy still remains intact. No action is required on the part of the individual to protect their privacy — it is built into the system, by default.
  - if a person doesn't demonstrate suspicious behaviour then nothing should happen with his personal data.
    - Including: the burden of system errors (false positives and false negatives) should not fall on the subject.

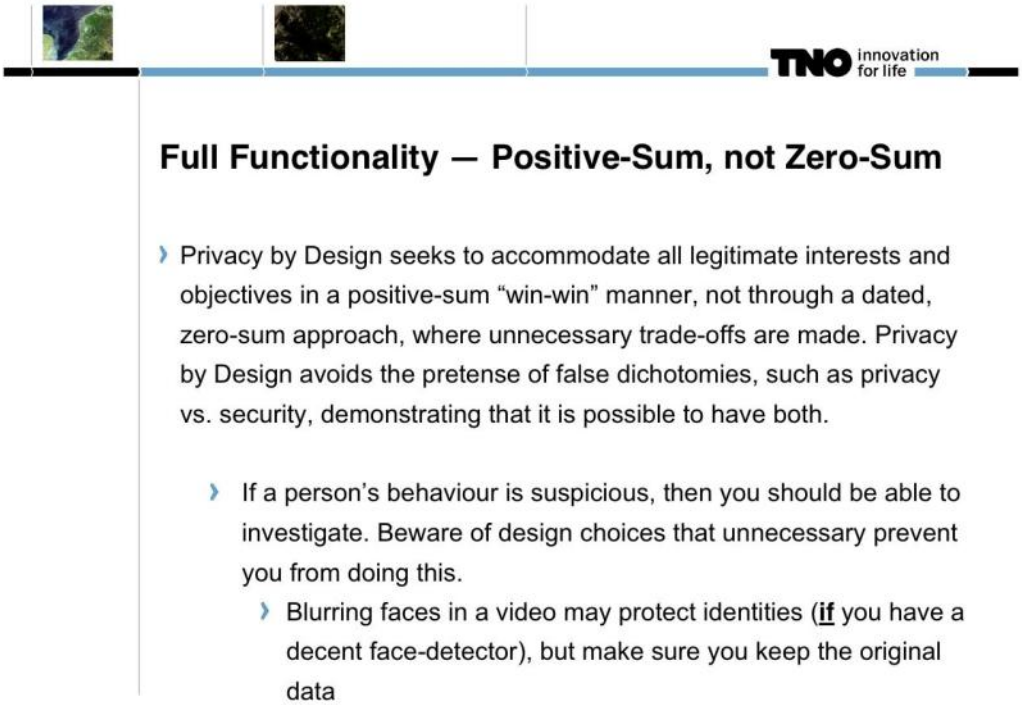
Privacy Embedded into Design

- Privacy by Design is embedded into the design and architecture of IT systems and business practices. It is not bolted on as an add-on, after the fact. The result is that privacy becomes an essential component of the core functionality being delivered. Privacy is integral to the system, without diminishing functionality.


TNO innovation for life
Tracking people might be needed to link multiple observations on them. Face recognition or a digital cloud (GSM, RFID, etc.) could be used to track them, however such technologies are out of proportion with that intended goal, because you can also *identify* persons with these technologies. There are alternatives with which people can be tracked without using personal data.


TNO innovation for life
Tracking people might be needed to link multiple observations on them. Face recognition or a digital cloud (GSM, RFID, etc.) could be used to track them, however such technologies are out of proportion with that intended goal, because you can also *identify* persons with these technologies. There are alternatives with which people can be tracked without using personal data.


TNO innovation for life
TRL=6 – Demo in an operational environment: Rotterdam-The Hague Airport
Performance of this demo-setup:
~30cm accuracy
live with <0,5 second delay, without hardware support
Increasing #viewpoints is more gentle growth-path for system owners than increasing resolution per viewpoint
(even when we have super-resolution operational)


TNO innovation for life
Full Functionality — Positive-Sum, not Zero-Sum
Privacy by Design seeks to accommodate all legitimate interests and objectives in a positive-sum "win-win" manner, not through a dated, zero-sum approach, where unnecessary trade-offs are made. Privacy by Design avoids the pretense of false dichotomies, such as privacy vs. security, demonstrating that it is possible to have both.
If a person's behaviour is suspicious, then you should be able to investigate. Beware of design choices that unnecessary prevent you from doing this.
Blurring faces in a video may protect identities (if you have a decent face-detector), but make sure you keep the original data

End-to-End Security — Full Lifecycle Protection

- Privacy by Design, having been embedded into the system prior to the first element of information being collected, extends securely throughout the entire lifecycle of the data involved — strong security measures are essential to privacy, from start to finish. This ensures that all data are securely retained, and then securely destroyed at the end of the process, in a timely fashion. Thus, Privacy by Design ensures cradle to grave, secure lifecycle management of information, end-to-end.
  - Delete surveillance footage and identifying metadata after the retention period.

Visibility and Transparency — Keep it Open

- Privacy by Design seeks to assure all stakeholders that whatever the business practice or technology involved, it is in fact, operating according to the stated promises and objectives, subject to independent verification. Its component parts and operations remain visible and transparent, to users and providers alike. Remember, trust but verify.
  - The list of suspicious behaviours could be classified information, but it should be controlled by a DPA or parliament.
  - Publish, also in popular media

Respect for User Privacy — Keep it User-Centric

- Above all, Privacy by Design requires architects and operators to keep the interests of the individual uppermost by offering such measures as strong privacy defaults, appropriate notice, and empowering user-friendly options. Keep it user-centric.
  - Where possible in your particular surveillance concept: stimulate choice of freedom and transparency. Explain that a persons' behaviour is directly controlling his privacy.

Establishment of a interoperability platform/centre for testing and validating security innovations - Network of Excellence

Topic SEC-2012 5.3-3 of EU Security call of 2011 July

TNO innovation for life

Outcomes

- a design process and methodology for testing and validation and/certification of security innovations in order to create shared platforms/centers for selected segments of the security market.
- business models for three characteristics cases, one at the level of **products**, one at the level of systems and one at the level of services.
- new collaborative networks for the three cases, with participation of end-users, suppliers of security products/systems/services and research networks.
- recommendations for (EU) policy and rules ensuring appropriate measures for initiating additional shared platforms/centers.

TNO innovation for life

Wrap up: standards for a maturing industry

- ☆ Definitions: suspicious behaviour
- ☆ Lingua Franka
- ☆ Privacy-by-Design
- ☆ Test and validation

Thank you!

Jeroen van Rest
+31 8886 68156, jeroen.vanrest@tno.nl

RATP connecting passengers: deploying operational video analysis in Paris Metro system

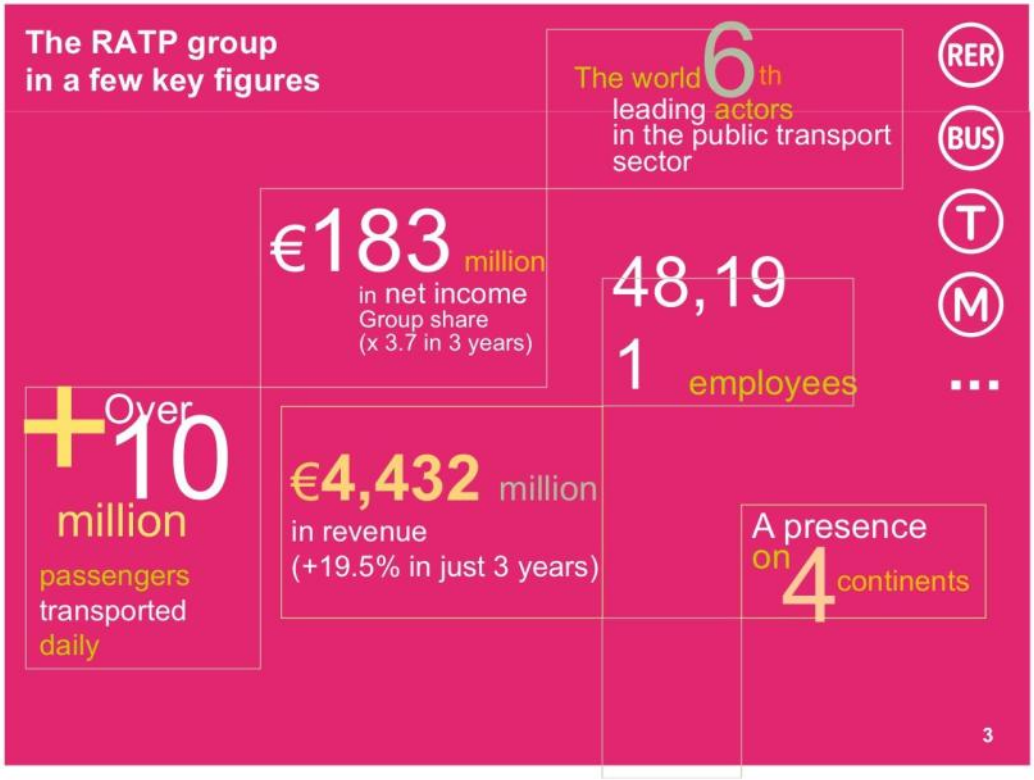
Fabrice SABOURIN
RATP, FR

RATP
connecting passengers

Our mission:

Offering the best transport service at the most attractive cost to
local public authorities

2


The RATP group
in a few key figures
The world 6th leading actors in the public transport sector
€183 million in net income Group share (x 3.7 in 3 years)
48,191 employees
+ Over 10 million passengers transported daily
€4,432 million in revenue (+19.5% in just 3 years)
A presence on 4 continents
RER
BUS
T
M
...
3


Expertise in all public transport modes
RER
BUS
T
M
...
4

RATP is also…
The Île-de-France region's original transit operator

- A public-sector corporation (EPIC status) created in 1949 in order to manage the world's number 1 multimodal network
- Owner and operations manager of the Île-de-France region transport infrastructure
- A company adapting to a market now open to competition
- A legally-mandated transitional period
  - Bus: 2025
  - Tramway: 2030
  - Metro and RER: 2040

Key figures:

200 km of metro lines

115 km of RER track

366 metro and train stations

A leader in transport operations

Metro: operating and modernising a 100-year-old system

- A density like nowhere else in the world
- Teams dedicated to passenger service
- A well-maintained and modernised network
- Yet a network facing the threat of oversaturation
- Despite leading-edge investments and technologies
  - Latest-generation and refurbished metro cars
  - Continuous speed control systems
  - Centralised control consoles/rooms
  - Platform screen doors
  - Introduction of automated features

M

300 stations

14 lines

Headways < **2** minutes on most lines

1.4 billion trips/year

7

The RER network: two regional axes

- 2 high-capacity lines responsible for transporting 450 million passengers a year

RER A

- Line A (east-west), a priority corridor
  - 35 stations over a 74-km route
  - Carries 1 million passengers 150 days a year, 25% of all Paris suburban passenger traffic
  - As of 2011: introduction of new, high-capacity facilities
  - A consistency plan introduced to cope with service saturation

RER B

- Line B (north-south), focus on interoperability features
  - 32 stations over a 40-km rail line
  - Interoperability with the SNCF since 2009
  - 2010-2013: line renovation plan

8

Bus service: a network shaping regional transport patterns

- Outstanding coverage
- A complex environment requiring strong technical competence
- Open line of communication with local authorities
  - Night-time service, express connections, local service
- A quality of service consistently getting better

BUS

350 lines

21,000 bus stops

Nearly **1.1** billion trips per year

+15% over the past 10 year

Mass transportation security

A more customer-friendly organization

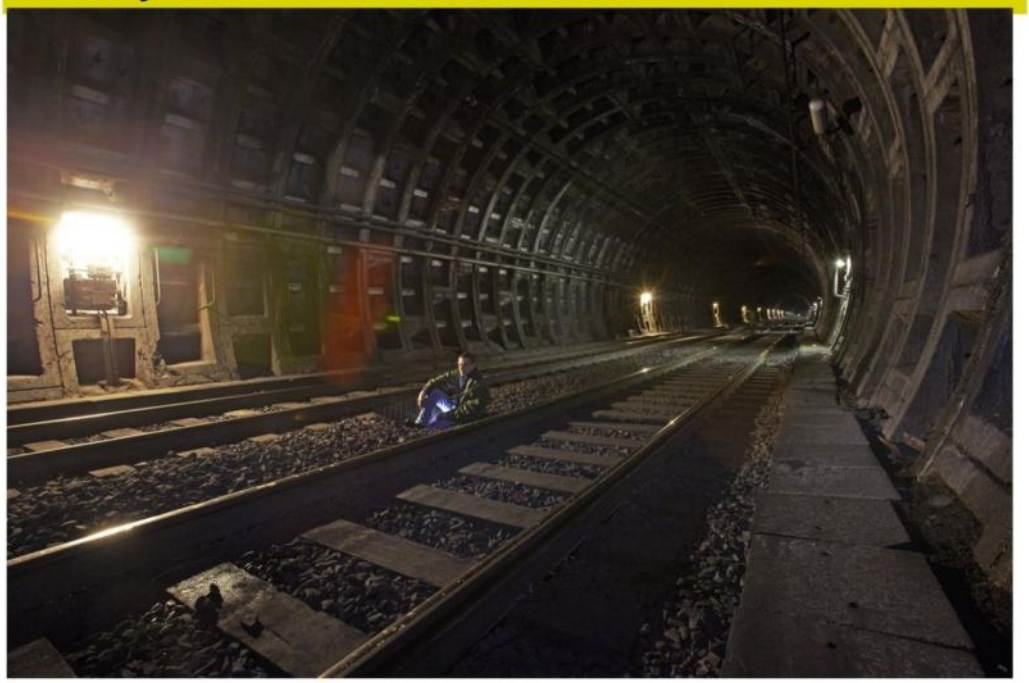
- Passager safety and security
  - Visible frontline security teams : 1,000 security officers
  - Daily coordination with regional transport police
  - Facilities that improve prevention, dissuasion and response times

11

Security engineering

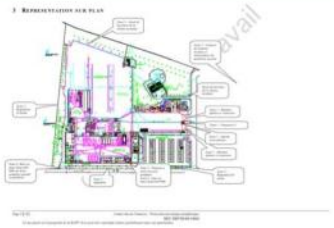
- Organisation
  - **Security operational systems**
  - **Public spaces security**
  - **Patrimonial security**
  - **Regulatory security studies, research and innovation projects, normalization**
- Functional requirements
  - **Security control center, video, radio, alarms treatment, …**
  - **Intrusion sensors, …**

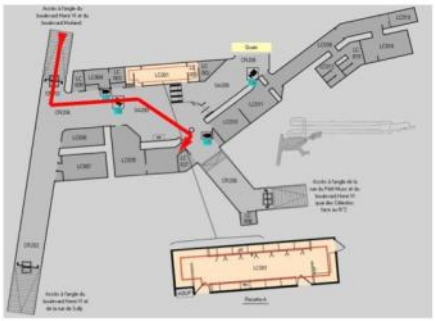
Security studies – Risks assessment



Engineering security service

- A long experience
  - Terrorist attacks
  - Delinquancy facts
- Project manager assistance
- Onsite expertise
  - Systra



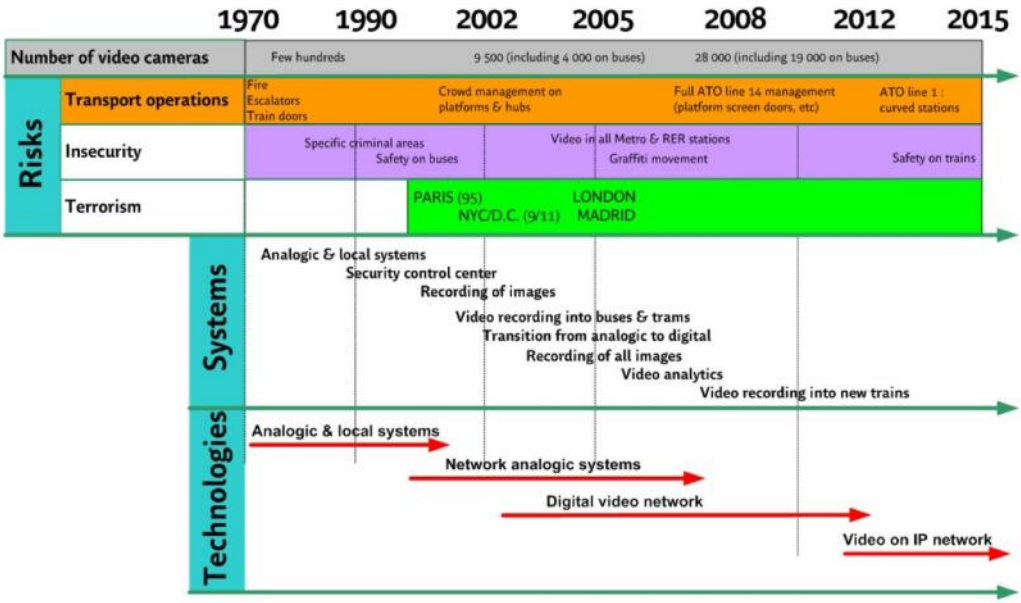


14

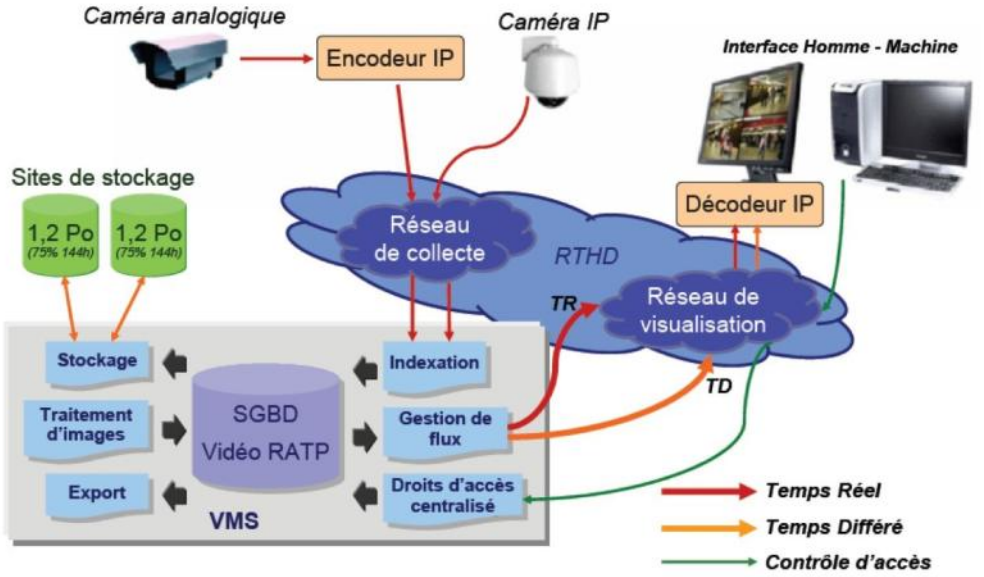
Urbanism code – security studies

- Diagnostic
  - Social, economic, lack of public safety
- Project analysis
  - Security risks, public safety risks
- Security measures
  - From mechanical protection to electronic detection
- Security items
  - Access check, flow management, video, defendable space separation, human management and procedures
  - Specifics vulnerability points, technical sensitive rooms and spaces treatment, security central centre
  - Funds transportation, light, sound and passengers information, infrastructure
  - Police and firemen access

History of video on RATP systems



New architecture for 2015



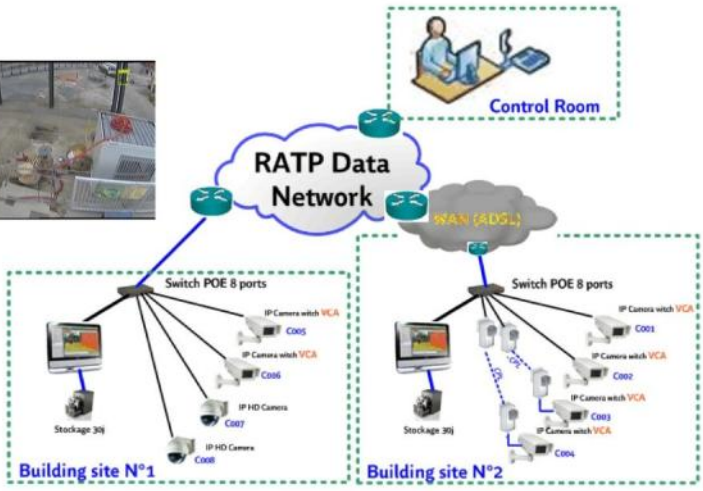
Videoprotection of train yards & strategical sites (PDS)

Videoprotection of train yards & strategical sites (PDS)

- Main characteristics:
  - First level of protection : mechanical protection & access control
  - Videoanalytics over train stabling areas
  - Under current experiment : RFID equipped cards automatically non generate alarms when entering protected zone

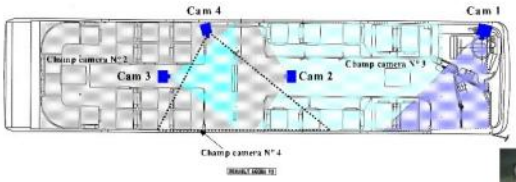
Protection of building sites

- **Main objective :** stealing on material & equipment
- **Principal characteristics :** basic & easy to install and adapt along the work period



Passenger density on buses

- **Ecological objective :** run less empty « big » buses
- **Result :** choose the right vehicule according to traffic
- Use of video analytics through existing cameras to detect periods of very low passenger density (inferior to 10 people per bus)



Local video security center for Châtelet - les Halles (CVM)

- Covers the biggest inner-city transport hub, right in the historical center
- RER : Châtelet les Halles lines A, B & D
- Metro stations : Châtelet (1, 4, 7, 11, 14), les Halles (4)
- 350+ cameras
- Traffic : 750 000 average visitors a day

Local video security center for Châtelet - les Halles (CVM)

- Operational from May 30th 2011 : random human surveillance from 12.00 till end of service (1.00)
- 3-year experiment

Local video security center for Châtelet - les Halles (CVM)

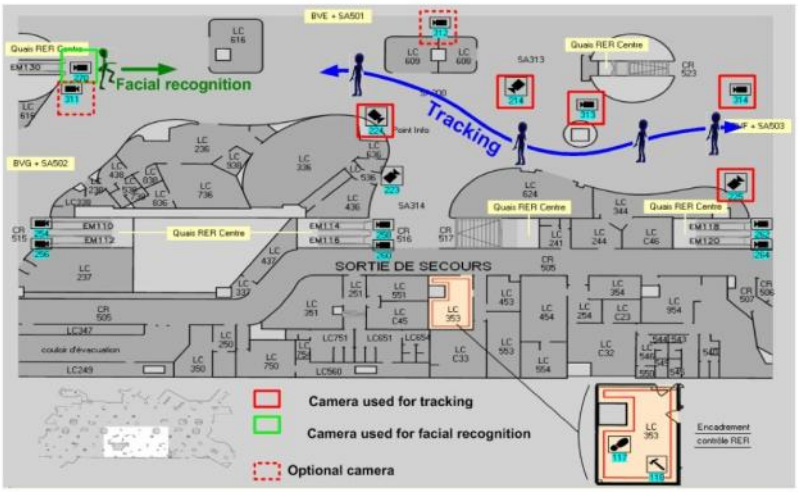
- On trial : use of live video analytics on defined scenarii
- Massive fraud
- Abandoned items
- Massive crowd (security & traffic)
- People collapsing
- Unusual behavior
- etc

Local video security center for Châtelet - les Halles (CVM)

- On trial : use of video analytics on recorded images
- Selection of « active » sequences
- Search with defined parameters (metadata)

Local video security center for Châtelet - les Halles (CVM)

- Tracking & facial recognition : Video-ID experiment



Local video security center for Châtelet - les Halles (CVM)

Secure-ED european project

- Paris trials includes video tracking via RER, Metro, tram & bus

Future projects

- Real-time video on surface vehicles and trains
  - Train/infrastructure and bus/tram transfer of live images
  - Use of video analytics on these video streams

29

THANKS FOR YOUR ATTENTION

aimer la ville

RATP

2009 key figures

RATP EPIC 2009 key figures

- 4,134 million euro **in revenues**
- 859 million euro **EBITDA**
- 153 million euro **in net earnings**

Investments: 1,246 M€

- Service provision **460 M €**
- Transport operation **485 M €**
- Rolling stock **207 M €**
- Not STIF related **48 M €**
- STIF and Île-de-France region **46 M €**

Journeys (in million)

- Metro **1,483.6**
- RER (regional trains) **462.0**
- Bus **1,086.3**
- Other services (Orlyval, STL) **7.5**

RATP Group 2009 key figures

- 4,432 million euro **in revenues** ↗ **+ 19.5 % in 3 years**
- 183 million euro **in net earnings**
- 341 million euro **EBIT**

31

Integrating innovative audio/video analysis tools in CCTV platform for urban transport: Turin and Paris use-cases

Cyril CARINCOTTE
MULTITEL, BE

VANAHEIM

YEAR #1 PUBLISHABLE SUMMARY

FEBRUARY 2010 – JULY 2013

Workshop

Emerging Surveillance Capabilities & Requirements

JRC Ispra, July 5-6, 2011

The research leading to these results has received funding from the European Community's Seventh Framework Programme FP7/2007-2013 - Challenge 2 - Cognitive Systems, Interaction, Robotics - Under grant agreement n° 248907-VANAHEIM.

MULTITEL – IMAGE PROCESSING DEPARTMENT

IMAGE PROCESSING DEPARTMENT :

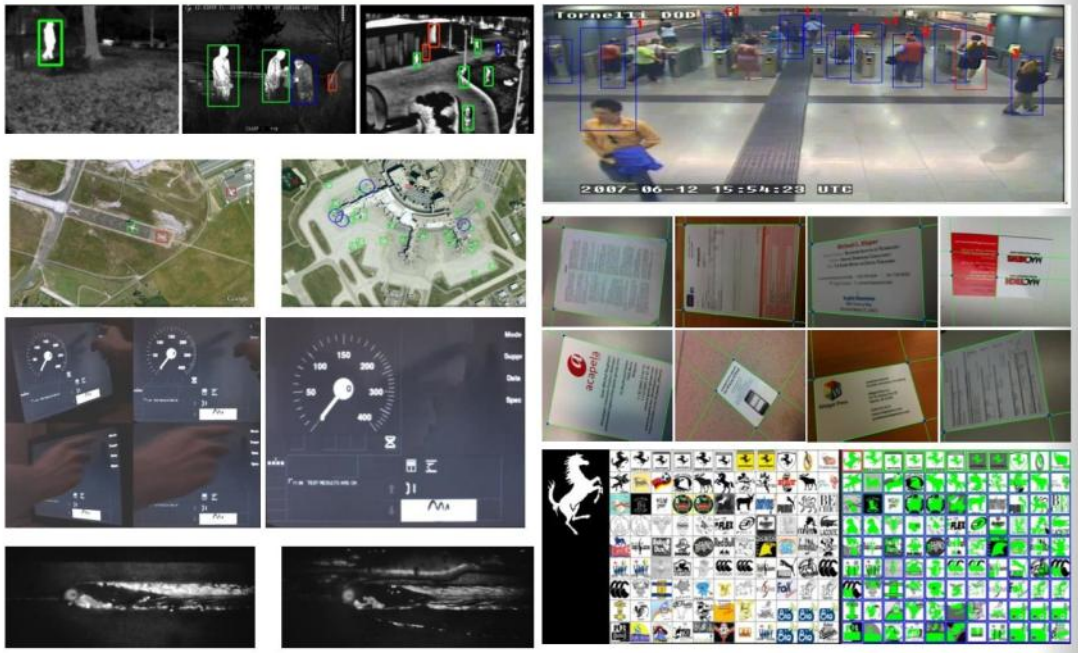
- Intelligent video surveillance applications
- Multimédia content analysis
- Machine vision

Scientific and technical activities for

- Partnership in national ou European collaborative projects
- Development software solutions & prototypes (industrial projects)
- Creation of « spin-off » Acic Video Analytics for video surveillance applications
  intrusion detection, road traffic monitoring, people counting, panoramic (blue) border monitoring, etc.

VANAHEIM

MULTITEL – ACHIEVEMENT EXAMPLES



VANAHEIM

MULTITEL – IMAGE PROJECTS OVERVIEW

On-going projects

Regional / National:
- **Secure-WMS (cctv & rtls dedicated to warehouse environment)**
- NDT-Laser (online laser beam welding defect detection)
- 3D-MEDIA (production, processing and display of 3D content)
- DETECT (person detection in video surveillance data)

Eureka:
- *ITEA*: CANTATA (adaptive multimedia content analysis)

EraSME:
- **TRACE-THEM (multi-modal localisation and tracking services)**

European Commission (FP7):
- VANAHEIM (audio/video analysis for metro stations monitoring)

European Defense Agency (EDA):
- HDR-HF (multimedia app. for high data rate HF modem)

Industry:
- Creaceed (development of corner detection module for iOS app.)
- Messio (prototype for similarity measure on logos for IPR company)
- ERTMS: European Rail Traffic Management System (Invensys, Ansaldo, etc.)

Past projects

Regional / National:
TRACING, CRYPTOMAT, TRICTRAC, CAPTEX, IRMA, IRM-FOCUS

Eureka:
CLOVIS, CANDELA, SERKET, TIFANIS, BOSS

European commision (FP6):
WCAM, WIDENS, MORYNE, CARETAKER

Industry:
- SNCF-BG
- SNCF-ARV (I/II)

VANAHEIM

VANAHEIM CONSORTIUM

Collaboration of

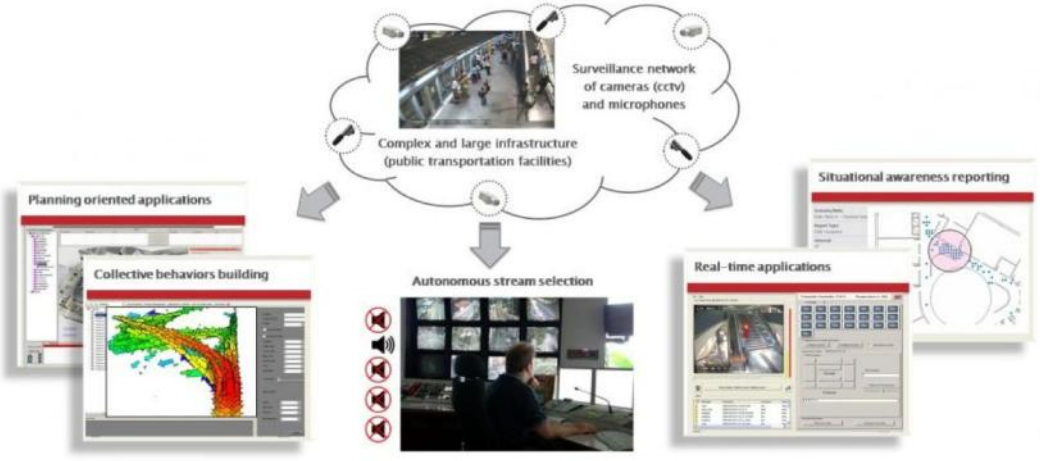
- **Computer vision & audio processing researchers**
  - Multitel asbl (MULT), **Belgium** (Coordinator)
  - Institut Dalle Molle d'Intelligence Artificielle Perceptive (IDIAP), **Switzerland**
  - Institut National de Recherche en Informatique et Automatique (INRIA), **France**
  - Thales Communications France (TCF), **France**
- **Human ethologists** (sociologist)
  - University of Vienna (UNIVIE), **Austria**
- **Surveillance system designer**
  - Thales Italia (THALIT), **Italy**
- **Public transport operators (metros)**
  - Gruppo Torinese Trasporti (GTT), **Italy**
  - Régie Autonome des Transports Parisiens (RATP), **France**

Large-scale integrating project (IP)

- ✓ **Duration**: 42 months (February 2010 –July 2013)
- ✓ **Budget**: 5.471.851 € (EU contribution 3.717.998 €)

OBJECTIVES

Integrate innovative audio/video analysis tools in cctv surveillance system for assessment in real-scale metro environment (Turin & Paris metros)



Scientific objectives:

- Audio/video data stream modeling
- Human behavior analysis
  - Human activity recognition (individual, group and crowd/flow of people)
  - Collective behavior modeling

Technological objectives:

- Development and deployment of system
- Technological & scientific assessments

AUTONOMOUS STREAM SELECTION

CURRENT SITUATION

CCTV video streams never watched (e.g. in Torino, 28 monitors for 800 cameras).

Common situation: monitors in control rooms show empty scenes/spaces,
(while many others cameras look at scenes in which something (even normal) is happening)

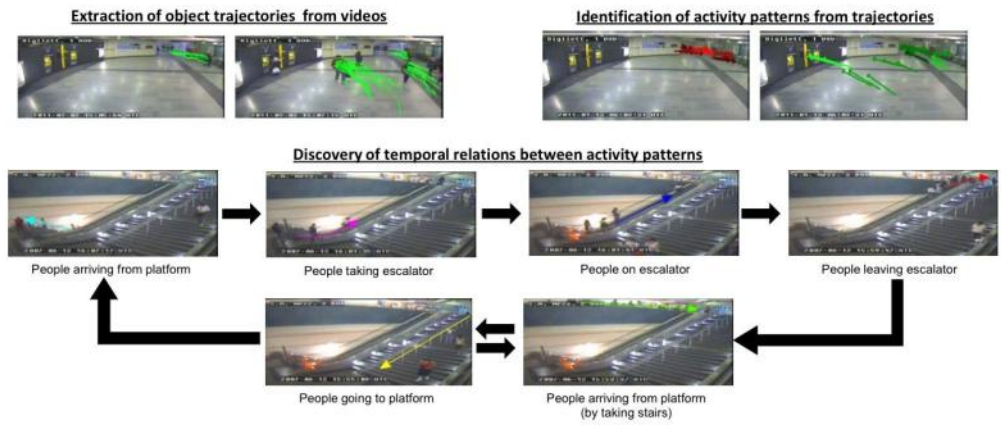
→ **Probability to watch right streams at right time is very limited**

VANAHEIM PROPOSAL – AUTOMATIC SENSOR SELECTION

- **Mechanisms for selecting relevant/salient audio/video streams in control rooms**
  - Models to characterise video streams content
    - Trivial scenario when dealing with "*empty vs occupied*" scenes
    - Challenging problem when almost all scenes are occupied
  - Need for unsuperised modelling is even more explicit for audio streams
    - "mosaicing" of data is impossible due to transparent nature of sound

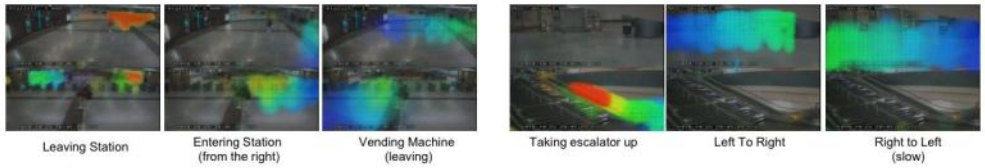
✓ ***Algorithms to model audio/video streams statistic normality and detect abnormal audio/video stream content***

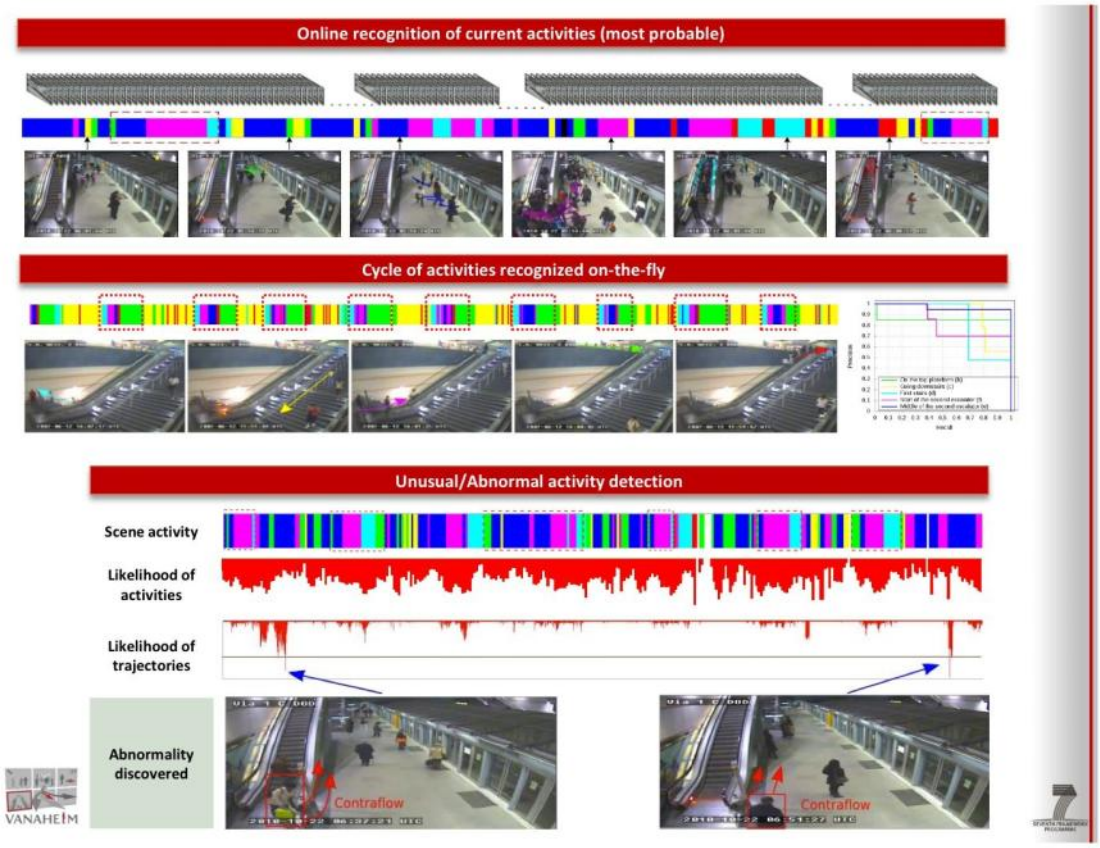
Automatic discovery of normal /usual activities (learning stage)

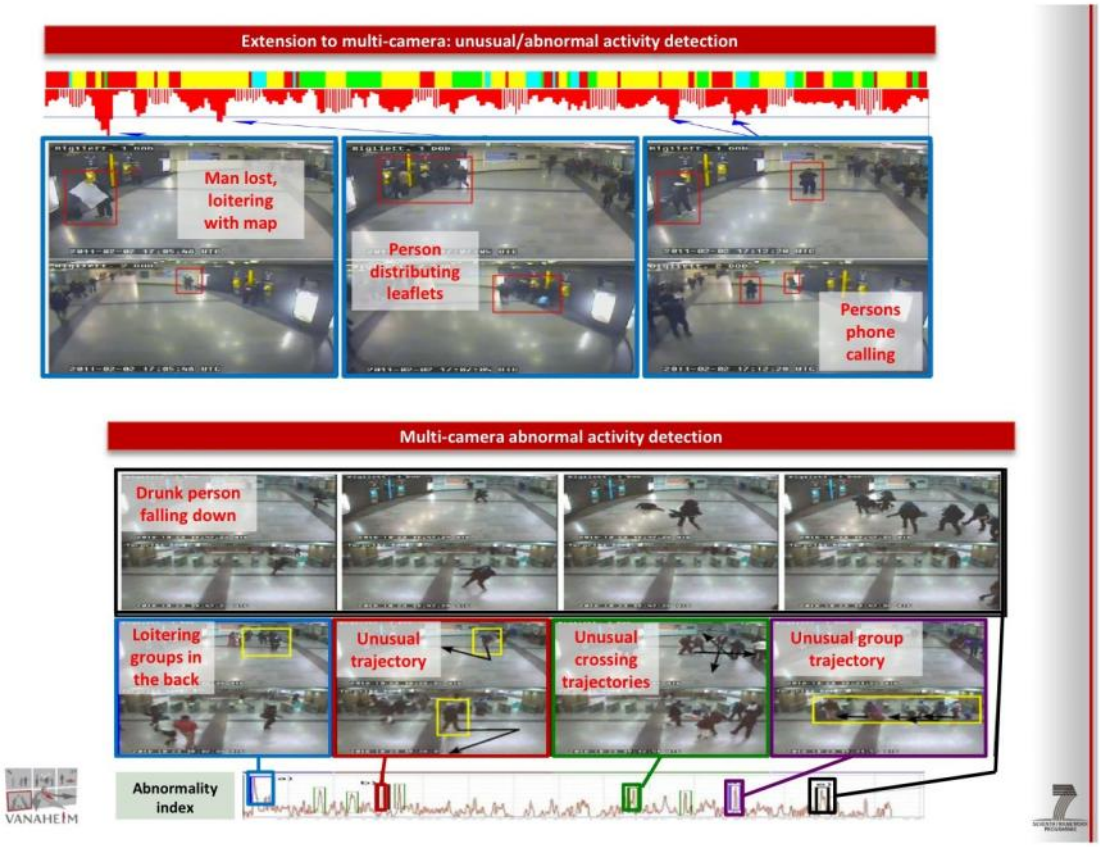


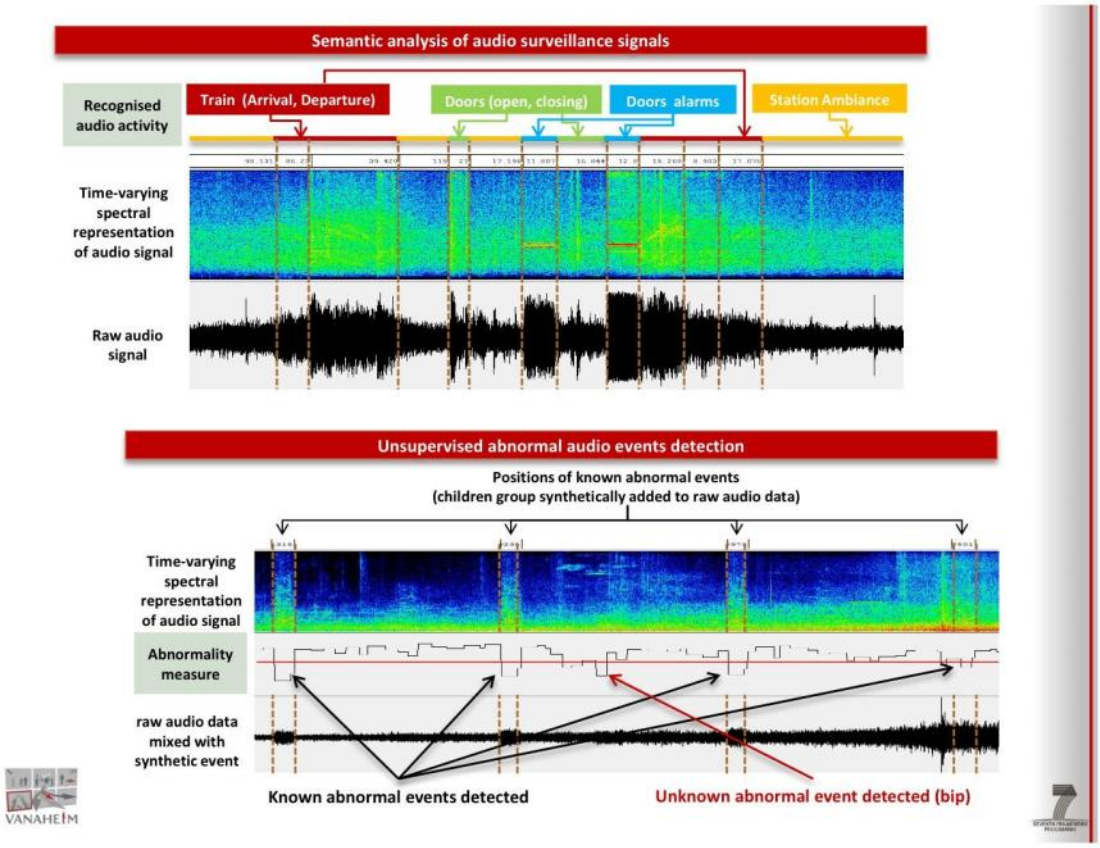
Automatic learning of normal activities from several hours of multi-camera videos

Activity representation: time represented with color gradient: beginnig in violet/blue, end in red




Online recognition of current activities (most probable)
Cycle of activities recognized on-the-fly
Unusual/Abnormal activity detection
Scene activity
Likelihood of activities
Likelihood of trajectories
Abnormality discovered
Contraflow
Contraflow
VANAHEIM


Extension to multi-camera: unusual/abnormal activity detection
Man lost, loitering with map
Person distributing leaflets
Persons phone calling
Multi-camera abnormal activity detection
Drunk person falling down
Loitering groups in the back
Unusual trajectory
Unusual crossing trajectories
Unusual group trajectory
Abnormality index
VANAHEIM



HUMAN-CENTRED MONITORING

CURRENT SITUATION

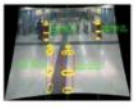
Human behaviour modelling : rarely exploited in Video Content Analysis

→ **Need for robust and reliable human-centred features**

VANAHEIM PROPOSAL – HUMAN-CENTRED MONITORING

Move one step beyond scene understanding based on location features

➢ Investigate **3 levels of human behaviours** characterization in surveillance data



➢ ***Individual level***

→ characterize an individual person with his/her activities.

➢ ***Group level***

→ detect small group of people and identify interactions in it.

➢ ***Crowd level***

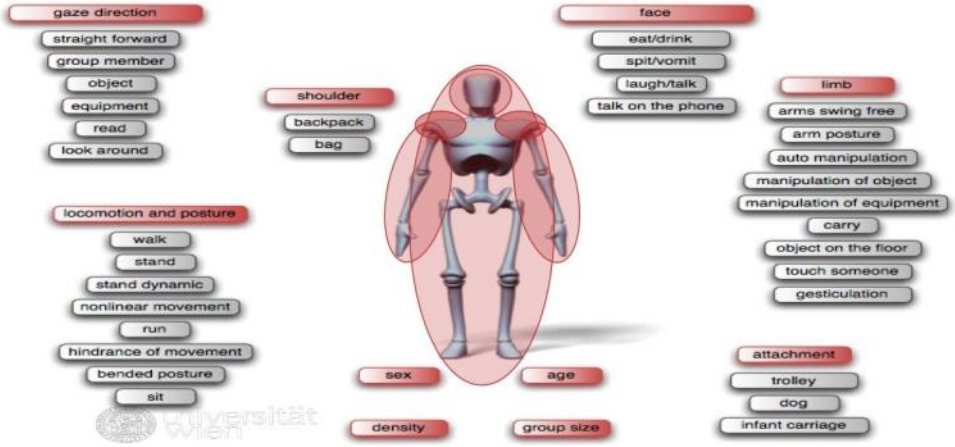
→ monitor crowd/flow of people (dynamics of collective people flow).

Two applications:

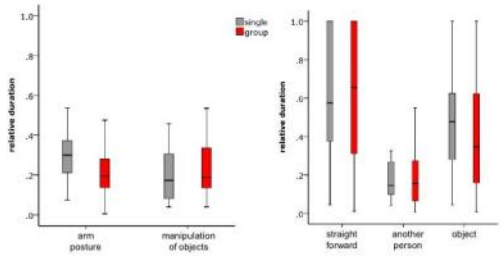
- ✓ **Event detection applications for safety/security**
- ✓ **Environmental reporting for situational awareness**

HUMAN-CENTRED MONITORING (BEHAVIOR ANNOTATION)

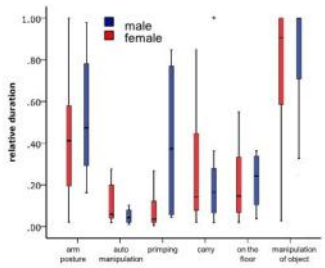
Human behaviour modelling : Development of a behavior catalogue including
not only behaviors regarded as interesting by user,
but covering behavior repertoire as completely as possible
→ **Catalogue of all behaviors of all people visible on video material**



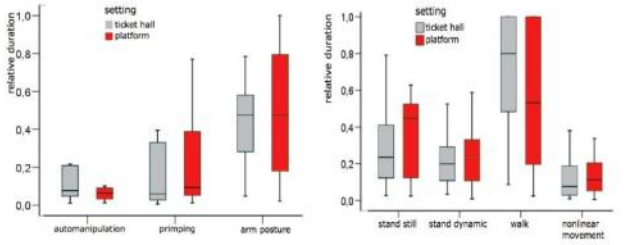
Behaviors with respect to sinlge or group

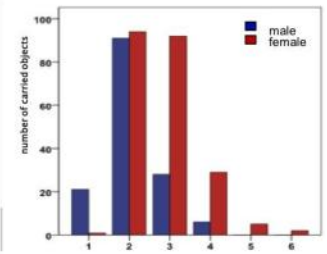


Behaviour with respect to sex



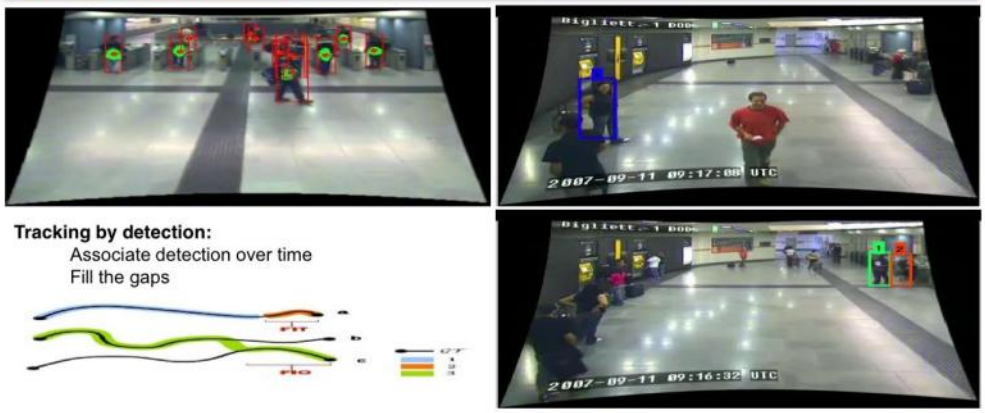
People posture and locomotion with respect to location (setting)





HUMAN-CENTRED MONITORING (INDIVIDUAL)

People tracking (tracking by detection)



Tracking by detection:

Associate detection over time

Fill the gaps

Body orientation estimation

Body + Head pose orientation estimation

VANAHEIM

HUMAN-CENTRED MONITORING (GROUP)

Head detection & tracking

People & head detection

Group detection & tracking

Event detection related to

Position:

- Group stays in zone (access zone, waiting zone…)
- Group close to/far from equipment/walls

Trajectory:

- Group stands still, group walks, and groups runs

Size:

- Constant size → calm group
- Medium variation → normal activity level
- High variation → lively group

VANAHEIM

HUMAN-CENTRED MONITORING (CROWD/FLOW)

People counting / flow monitoring in escalator

Measurements:

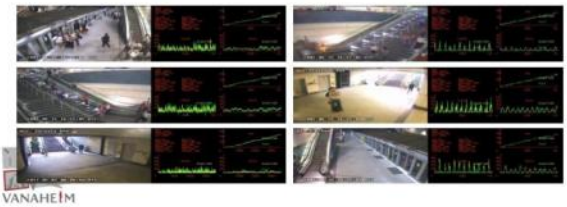
- cumulative people counting over time (pers.)
- person flow per minute (pers./min)

People leaving the platform

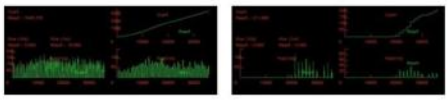
→ Periodic flow

People entering the station

→Random flow



- Identification of trends
  - → e.g. weekdays vs week-end days



VANAHEIM

LONG-TERM COLLECTIVE BEHAVIOUR BUILDING (not started yet)

CURRENT SITUATION

Transportation terminals are increasingly subject to capacity problems

- Need expressed by managers for **analysis of passenger dynamics/behaviors**
- Bottleneck consist in high variety/complexity of passenger behaviours

VANAHEIM PROPOSAL – LONG-TERM COLLECTIVE BEHAVIOUR BUILDING

- System able to **identify & characterize structures inherent in *collective behavior***
  - models that can learn, analyze and cluster *individual behavioral information*

Continuous monitoring of user information

- locations, routes,
- spatio-temporal activities (walking, waiting...),
- interactions with others passengers and/or equipments,
- contextual data (time of day, density of people...)

Goal: estimate **trends of large-scale human behaviour at an infrastructure level,** e.g. to

✓ Localize common loitering areas and/or highly frequented aisles

✓ Identify traffic patterns in the infrastructure, etc.

VANAHEIM

WORKSHOPS

Two workshops on Behavior Analysis

Behaviour Analysis and Video Understanding

When & where

- **Workshop** : September 23, 2011
- **Location** : Sophia Antipolis, in conjunction with the 8th Int. Conf. on Computer Vision Systems
- **Submission of full papers** : Extended to July 8, 2011

Interactive Human Behavior Analysis in Open or Public Spaces

When & where

- **Workshop** : November 16, 2011
- **Location** : Amsterdam, in conjunction with the 2011 Ambient Intelligence Conference
- **Paper submission deadline** : July 25, 2011

VANAHEIM

USER-BOARD

Representative of

- ✓ **CCTV end-users** (security/safety operators, public infrastructure managers...)
- ✓ **Surveillance system designers**, manufacturers and suppliers
- ✓ **Video Content Analysis** (VCA) solutions providers

Member organisation	Area of expertise	Country
ACIC sa	IVS/VCA supplier	Belgium
Keeneo	IVS/VCA supplier	France
Thalès Transportation System	Transportation system designer	France
ACTS Linea Spa	System end-user	Italy
Azienda Mobilità e Trasporti AMT (Genova)	System end-user	Italy
Maptel	CCTV vendor	Italy
GE Security	CCTV vendor/VCA supplier	Switzerland
swisspro	CCTV vendor	Switzerland
Siemens AG*	Comm. and media solution provider	Austria
---*	---	Belgium
---*	---	Denmark
Sec-Control Group*	System end-user	Finland
AXIS*	CCTV vendor - IVS/VCA supplier	France
Pilot Centre for Urban Security (PPSL)*	Public safety technologies experimentation	France
Azienda Trasporti Milanesi ATM*	System end-user	Italy
University of Florence MICC*	Video Surveillance Research	Italy
Ericsson AS*	Transportation system designer	Norway
Niklas SA*	CCTV vendor	Switzerland
Sony Overseas SA*	CCTV vendor	Switzerland
Firstec SA*	CCTV vendor	Switzerland
University of Leeds*	Surveillance ethicist	UK
Digital Grape Business Services*	Transportation system designer - Other	UK
Carnegie Mellon University*	Audio and Video Analytics Research	USA
March Networks*	CCTV, IVS & Transportation system vendor	USA

VANAHEIM

NEXT STEPS

- *Pursue Audio/Video analysis development*
- *Start long-term collective behaviour building*

- *Iterative development cycle*
  - *→ Preliminary integration in second semester 2011.*
  - *→ First demonstration at Turin planed for Feb. 2012 !*

- *Preliminary assessment in real-scale environment (Turin)*

Survey on Audio & Video Content Analysis for Transportation applications
Currently on-line at

Closing Session

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Emerging Surveillance Capabilities & Requirements

Workshop, JRC Ispra, July 5-6, 2011

Conclusions and follow-up

F. Andritsos

Slide 1 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Contents

- Preliminary WS summary
- Collaboration opportunities
- EC financed RTD opportunities
- EU security research

Slide 2 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Preliminary WS summary #1

Technology - 2 classes of applications:

- 'abnormality' detection
- 'tracking' in difficult environments

Questions / issues

- Need for HD? Not always
- Is visual information enough? No

Slide 3 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Preliminary WS summary #2

Way ahead:

- Image / video from many sources
- Learning on the go
- Video combined with other sensors
  - RFID, sound, GSM signal etc
- Advanced architectures
- Multi-level standards

Slide 4 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Preliminary WS summary #3

Societal requirements / issues:

liberties, safety, security, privacy, welfare

- Increasingly pervasiveness
- Unpredictability
- Multi purpose

- Public perception (ID control)

Slide 5 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Preliminary WS summary #4

Way ahead:

- Embed societal concerns as design parameters
- Regulations / market
- Privacy by design (of what?)
- Life-cycle approach
- High level (functionalities & architecture)

Slide 6 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

Collaboration opportunities

- Joint publications & workshops
- Targeted bilateral collaboration
- Partnership in RTD projects
- Exchange of personnel
  - JRC personnel on 'sabbatical'
  - JRC can host 'visiting staff'
  - JRC can host grant-holders
  - Temporary staff

Slide 7 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

EC financed opportunities

- FP7 Research
  - Security program
  - ICT program
  - FET
  - Other thematic programs
- Direct support to Commission & other EU institutions

Slide 8 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

EU security research

To be published at the end of July
Proposal submission deadline November

Info on a draft public version

JRC cannot be the coordinator

Slide 9 Emerging Surveillance Capabilities & Requirements

JRC EUROPEAN COMMISSION
Institute for the Protection and Security of the Citizen

SURCIT
Surveillance Technologies & the Citizen

EU security research - selected 2012 topics

Topic SEC-2012.6.1-2
Capability Project or Coordination and Support Action
Tools and methodologies, definitions and strategies for privacy by design for surveillance technologies, including ICT systems

Topic SEC-2012.4.2-2 *Integration Project*
Situational awareness guidance and evacuation systems for large crowds, including crowds unpredictable behaviour

Topic SEC-2012.6.1-3
Capability Project or Coordination and Support Action
Use of new communication/social media in crisis situations

Topic SEC-2012.2.3-1 *Capability Project*
Early warning security systems: physical protection of critical buildings

Topic SEC-2012.5.3-3 *Network of excellence*
Establishment of a interoperability platform/center for testing and validating security innovations

Slide 10 Emerging Surveillance Capabilities & Requirements

European Commission
EUR 24958 EN – Joint Research Centre – Institute for the Protection and Security of the Citizen
Title: Workshop on Emerging Surveillance Capabilities and Requirements
Authors: M. GEMO, F. ANDRITSOS
Luxembourg: Publications Office of the European Union
2011 – 294 pp. – 21 x 30 cm
EUR – Scientific and Technical Research series – ISSN 1831-9424 (online), ISSN 1018-5593 (print)
ISBN 978-92-79-21467-7
doi:10.2788/80181

Abstract

On 5-6 July 2011, the Joint Research Center (JRC) of the European Commission organized a workshop on "Emerging Surveillance Capabilities and Requirements". Around 30 leaders, researchers and practitioners from European RTD institutes or academia, operators and leading system / equipment providers attended the workshop. The workshop was hosted by the Institute for the Protection and Security of the Citizen (IPSC) of the JRC (http://ipsc.jrc.ec.europa.eu/), in Ispra, Italy.

This report summarizes the workshop's contents and the main findings agreed during the closing session. It also contains every PowerPoint presentation which had been showed except the ones for which a confidentiality clause was required.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

LB-NA-24958-EN-N